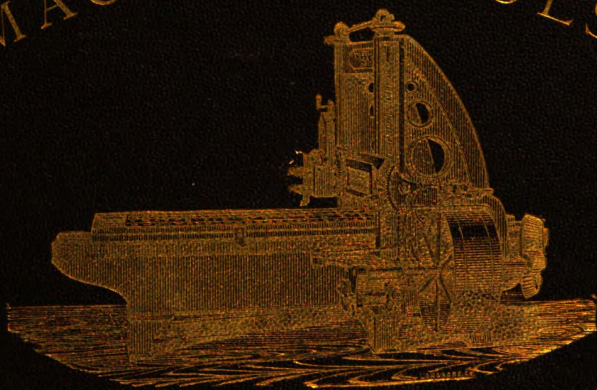


MACHINE TOOLS.



WM. SELLERS & CO.

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A TREATISE  
ON  
MACHINE TOOLS, ETC.,

AS MADE BY.

WM. SELLERS & CO.,  
1600 Hamilton Street, Philadelphia, U.S.,

MANUFACTURERS OF

MACHINISTS', FOUNDERS', SMITHS', AND BOILER-  
MAKERS' TOOLS,

SHAFTING AND MILL GEARING,

RAILWAY TURNING AND TRANSFER TABLES,

PIVOT BRIDGES, ETC.;

MANUFACTURERS OF THE

MOST IMPROVED FORMS OF INJECTOR BOILER-FEEDERS;

AND

SOLE MANUFACTURERS OF THE SELF-ADJUSTING INJECTOR.

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PHILADELPHIA:  
PRINTED BY J. B. LIPPINCOTT & CO.

1873.

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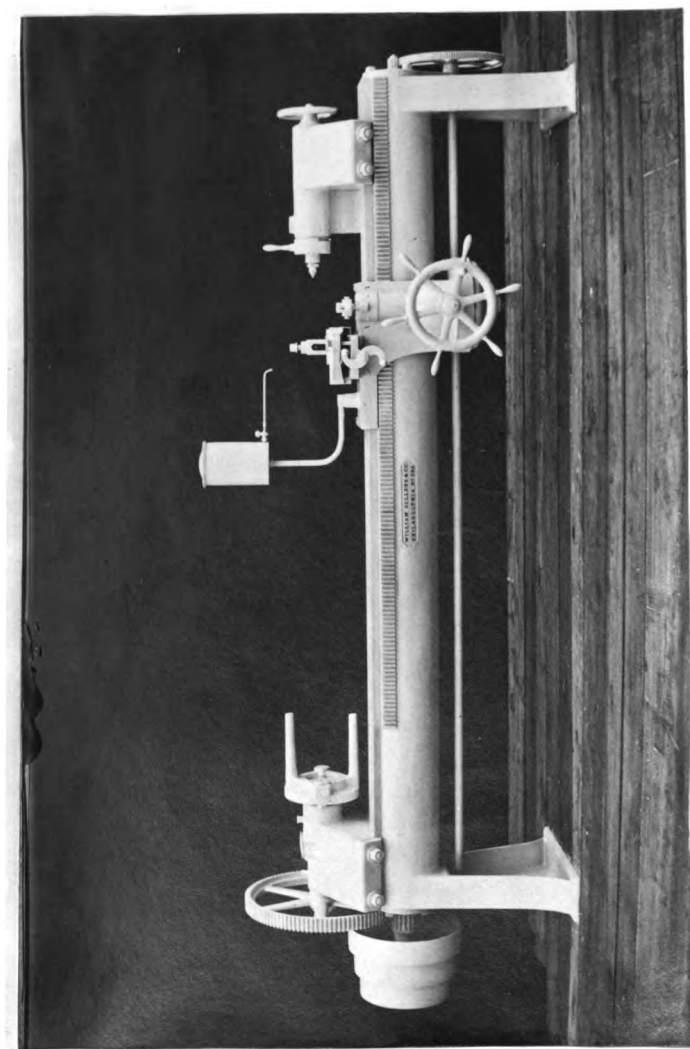
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# MACHINE TOOLS.





## AXLE LATHE,

For turning car wheel axles; strongly geared for taking heavy cut; Clement's driver on face plate; rack feed with quick hand traverse to bottom rest; patent adjustable tool holder; automatic feed motion, which can be started instantly; rate of feed, 15 to the inch; can to drop water on cutting tool. All working parts fended from chips and water. Iron cone pulleys, turned inside, so as to be perfectly balanced; over-head shaft, with ball and socket hangers, and two sets of fast and loose pulleys, viz., 20 inches diameter, 4 inches face, which should run 120 revolutions per minute, and 12 inches diameter, 4 inches face, which should run 200 revolutions per minute. A full set of wrought iron wrenches. Wrought iron work case hardened.

THIS is one of our very important special tools, and in its design we had in view not only the greatest possible production, in work done in a given time, but also the greatest perfection possible in the work produced by not necessarily skilled workmen. In turning car axles there are two essential parts to be treated,—the “fit,” that is, the part upon which the wheel is forced, and which requires accuracy of size; the journal, which demands less accuracy of diameter, but requires to be truly cylindrical and of smooth surface. It is customary to rough out the journal at one cut, taking out from  $\frac{3}{4}$  of an inch to  $\frac{1}{4}$  of an inch depth of metal, with a feed of 15 to the inch. This very heavy cut makes a great strain on the axle, and if, in addition to this strain, the mode of rotating the axle is not of such a nature as to insure its not being strained sideways at the face plate or driving end of the axle, the work produced will be out of round. It has been found that more

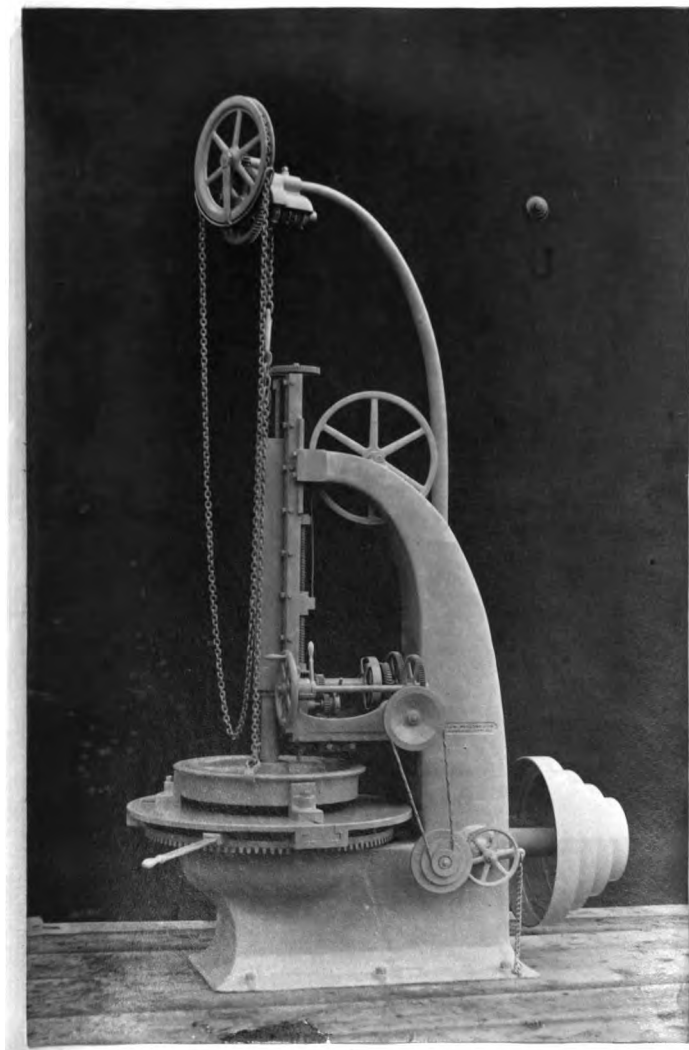
**Turns one end at a time.** and better work can be done with properly constructed lathes which turn but one end of the axle at a time than when the attempt is made to turn both ends at once, driving from the centre of the axle, as in the so-called double-headed axle lathes.

**Convenience.** In turning the greatest possible number of axles in any given time, it is of importance that all the motions required to be made by the workman shall be done quickly; hence convenience of adjustment and handling becomes an essential feature of the machine. **Shape of shears.** The shears or bed is made in the form of a continuous cylinder of requisite strength, with flat surfaces added to the cylinder for attachment of heads and bearing of slide rest. **Face plate.** The live head or driving head is simple and powerful. The face plate is fitted with the so-called Clement's driver, which insures rotation of axle with no lateral strain on the centres. **Back head.** The back head has a very large, well-fitted spindle, with unusually large centre and a clamping arrangement, which insures the spindle being held central and at the point nearest to the work. On top of this head is a grease box to hold the lubricant for the centre at the handiest place for oiling the centre as the axle is being put into place. **Slide rest.** The slide rest, which is massive and strong, has an improved method of adjusting the point of the tool while under-cut with care and precision. **Feed.** The feed is by a rack, with a clutch to stop and start, and, in addition, there is a powerful hand feed also. A water tank above the tool drips water on the work being turned, and proper guards turn aside the water and chips from the wearing surfaces. With these conveniences it is possible for one man to produce from 18 to 20 axles in ten hours. **Production.** The value of the turned ends of car axles is

assumed in this country to be fifty cents each,—i.e. <sup>Value of work done.</sup> one dollar per axle. It has been demonstrated that our lathe will enable an ordinary workman to turn at least two axles per day more than the same man can produce on the best machine heretofore made by any other maker. This represents a yearly increase of production equal to \$600, representing the interest on \$6000, at 10 per cent., a gain which will certainly warrant the payment of two or three hundred dollars over the price of similar machines that do less work.

In operating these lathes there are two speeds on the counter-shaft, the slow one for the roughing cut, and the fast one for the finishing cut.

The fast and loose pulley, 20 inches diameter, 4 <sup>Speeds.</sup> inches face, should make 120 revolutions per minute, and those 12 inches diameter, 4 inches face, should make 200 revolutions per minute. These speeds may be obtained by driving from the same size pulley on the line.



## CAR WHEEL BORING MILL,

For car wheels up to 36-inch, and general work up to 48-inch diameter. Boring bar operated from above; the bearing for bar adjusted vertically. The vertical slide holding boring bar, counter-balanced and arranged with power feed, and quick hand traverse in either direction. The revolving table arranged with universal chuck for all sizes up to 36-inch diameter. In addition to the boring machinery, an adjustable *Hub Facing Attachment* is provided, the slide of which is independent of the boring machinery, so that a hub may be faced off and bored at the same time. Over-head shaft with ball and socket hangers and iron cone pulleys, turned inside, so as to be perfectly balanced; full set of wrought iron wrenches. Wrought iron work case hardened. Fast and loose pulleys, on counter-shaft 24 inches diameter for 4-inch belt, which shaft should make 60 revolutions per minute.

THIS machine, called also 48-inch Boring Machine, has same face plate, chuck, and means or method of driving as Patent Boring Mill, but the boring bar is forced down from above the wheel being bored, and may be larger than in the case of Patent Mill. This machine is more efficient, also, and has the advantage of being able to turn off the face of hubs of locomotive truck wheels. To it we adapt a patent safety crane attachment when desired (*see photograph*). In boring cast iron car wheels, it is customary to take out the bulk of the metal to be removed, by a double-ended cutter in the boring bar, at one operation, and with a fine feed; then to finish with a very coarse feed, taking out but little metal. This hurrying through of the finishing tool, with little work being done, insures uniformity of size of hole.

Crane attachment.

For speed see specification above.

- Capacity.** Capacity of work may be stated as 50 car wheels in 10 hours.
- Speed.** Pulley on counter-shaft 24 inches diameter, 4-inch belt, 60 revolutions per minute.

## MEMORANDUM FOR BORING CAR WHEELS.

- Speed of cut.** In boring car wheels, assuming the usual size eye, viz.,  $4\frac{1}{8}$  inches diameter,  $6\frac{1}{2}$  inches length of hub, with a core  $3\frac{3}{4}$  inches diameter, the mill should be run at a speed that will give (12) twelve turns per minute to the wheel, thus making speed of cut about 13 feet per minute.. The roughing tool should make the hole  $4\frac{3}{8}$  inches, leaving  $\frac{1}{8}$  inch for the finishing cut. The speed of the feed on roughing cut should be 8 to the inch; each end of the cutter having  $\frac{1}{16}$  inch feed. At this rate, the roughing cut can be run through in  $4\frac{1}{2}$  minutes. The finishing cut should have not less than  $\frac{1}{4}$  inch feed, running its cut through in a little over 2 minutes. The two cuts should take  $6\frac{1}{2}$  minutes, or 7 minutes at the utmost. The number of wheels bored per day will depend upon the quickness of the man changing the cutters and shifting the wheels; allowing 5 minutes for changing cutters, facing off hubs, and shifting wheels, 50 wheels should be bored every 10 hours.
- Number of wheels bored.**
- Example of work done.** At A. Whitney & Sons' works, their regular day's work is 60 wheels in 10 hours; but on a trial of speed, one man bored 100 wheels on one mill in 10 hours, or one every 6 minutes. To do this he ran the mill faster than usual, making the cutting speed about 18 feet per minute, and finishing on a feed of  $\frac{3}{8}$  of an inch.
- Shape of cutters.** The cutters are always made double ended, and are turned up square to begin with, thus :



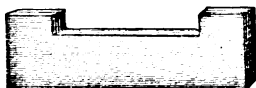


Fig. 1.

but as they become dull they are ground off into a shape, thus :



Fig. 2.

and are said to work better after the cutter has begun to be oblique. The finishing cutter, having but little to do, does not wear away very rapidly ; in fact, its deterioration depends more upon the time taken to run it through the wheel, than upon the amount of metal removed by it. A fine feed on the finishing cut wears the cutter more than a quick one. The coarser the feed, within reasonable limits, the longer the cutter will remain to size.

Coarse feed for finishing.

The fast or roughing cut will require the cutter to be ground up for every 4 or 5 wheels. The finishing cutter used as above—*i.e.* with  $\frac{1}{8}$  of an inch cut on each end,  $\frac{1}{4}$  of an inch feed—will last for 50 wheels with no appreciable change in size. Sometimes cutters have been found that would size 250 wheels with no deterioration. They are always made soft in the middle and hard at the cutting ends. As soon as they show any wear they are stretched to length by paning the soft part in middle of cutter with a hammer. The gauge used for testing the size of bore is a piece of steel like a cutter, made of 1 inch by  $\frac{3}{8}$  of an inch steel, ground to the proper size after hardening, thus, rounded to hole narrow way of the ends, so as to be inserted edgeway :

Durability of cutter.

Gauge.



Fig. 3.

Size of axle in "fit." Axles are turned about .007 of an inch larger than the bore of wheel; with the difference of size the force required to push on the wheel is from 20 to 30 tons, and the wheel will not come loose in use.

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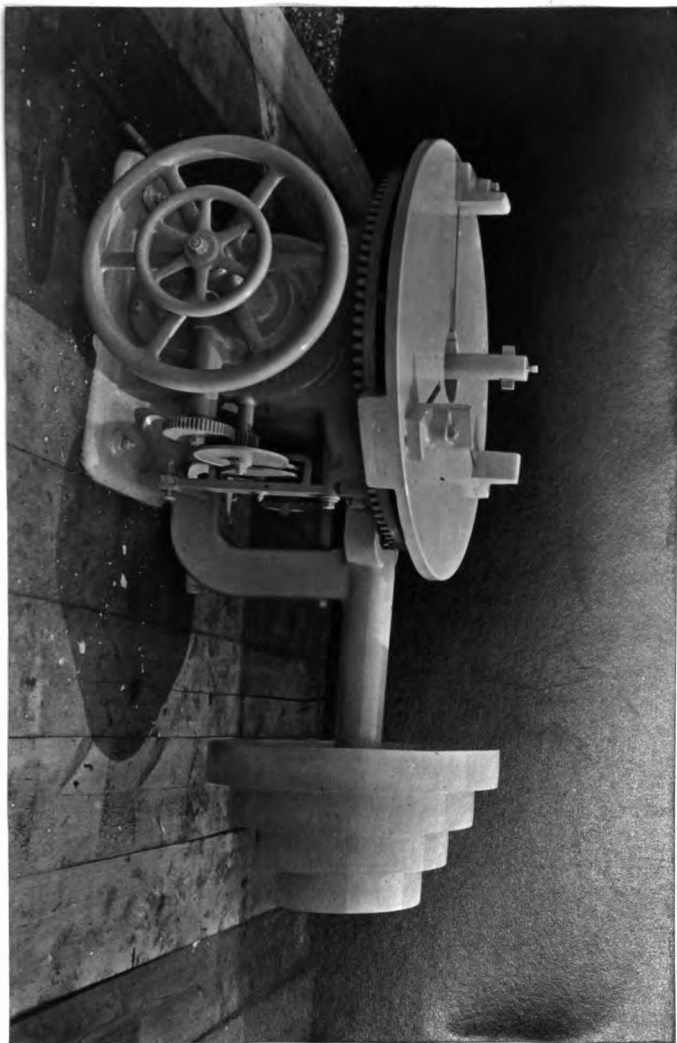
### PATENT BORING MILL,

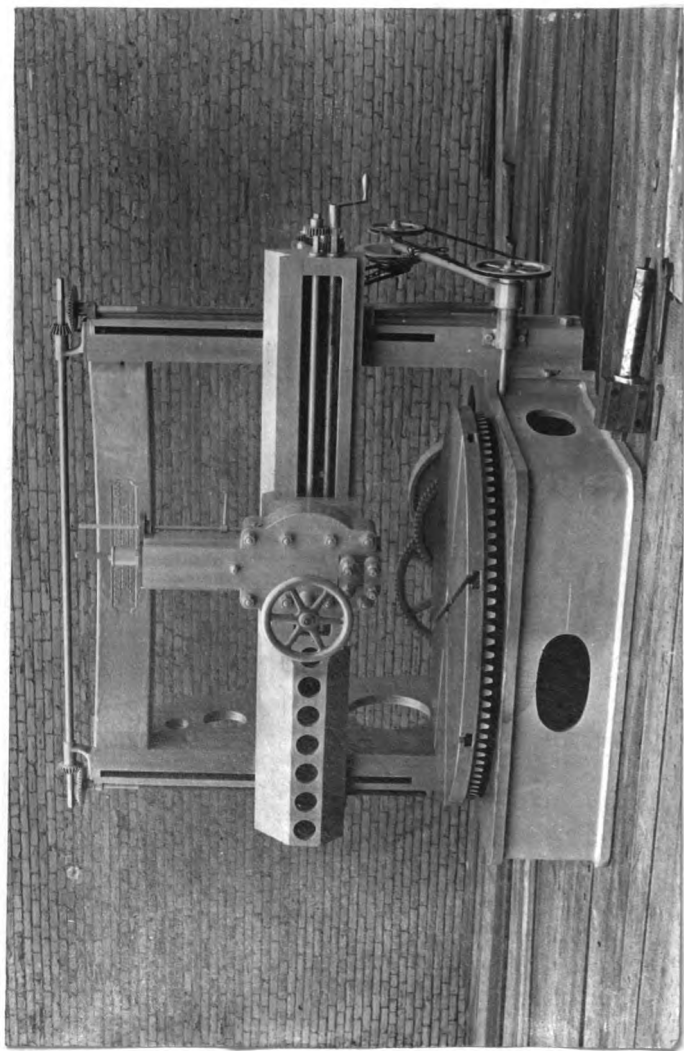
For car wheels and general work, fitted with universal chuck for all sizes up to 36 inches diameter, and capable of boring driving wheels 6 feet in diameter; cross head for holding boring bar counter-balanced and arranged with power feed and quick hand traverse in either direction; the sliding surfaces always clear of chips, which can fall through the face plate as in mills where the bar is supported above; with over-head shaft, iron cone pulleys turned inside so as to be perfectly balanced; ball and socket hangers, and a full set of wrought iron wrenches. Wrought iron work case hardened.

**T**HIS is a useful tool for boring only; is adapted to bore car wheels up to 36 inches in the chuck on the face plate; will bore a wheel 6 feet in diameter. It uses boring bars with double-ended cutters only, the bar being carried by a cross head below the table; boring bar fitted with gib cutters. The bar must be small enough to pass through the hole in wheel before it is bored. Counter shaft has 24 inches by 4 inches fast and loose pulleys, which should make 60 revolutions per minute; bed of machine must rest on foundation walls, allowing part of the guides for cross head to extend below level of floor.

Size of bar.

Speed.





## BORING AND TURNING MILL

WITH

### COMPOUND SLIDE REST AND BORING BAR COMPLETE.

The holder for boring bar is so arranged as to be easily removed and a turning tool substituted; feeds self-acting in all directions, and at all angles; quick return motion to boring bar; face plate resting in an angular bearing after the manner of the slide of a planing machine; with an adjustable centre step to take any amount of the vertical strain that may be desired; over-head shaft; iron cone pulleys turned inside so as to be perfectly balanced; ball and socket hangers and wrought iron wrenches complete. Wrought iron work case hardened.

**T**HESE mills, the smallest of which has a capacity of 84 inches, are adapted to bore with a boring bar having a double-ended cutter, or to bore with a single-pointed tool. Can be advantageously used in both boring and turning large pulleys, and in doing all work usually done on a facing lathe, with the advantage of ease of chucking, inasmuch as the face plate being horizontal, work laid upon it may be moved about until correctly centred and then clamped to place. These mills have no part of the machinery extending below the surface of the floor upon which they rest. They should be placed on foundation walls so built as to make a pit below the centre of machine, into which chips fall, to be removed at convenience. Many of them are used in locomotive shops for boring truck wheels and tire. Numbers of driving boxes also are placed in a circle on the plate and faced off at one operation in an

Face plate horizontal.

Foundation.

**Feeds.**

economical manner. The feeds are so arranged as to enable the roughing cut to be made with fine feed, but the finishing cuts with very broad feed, say  $\frac{3}{8}$  inch to a revolution, to prevent wear of finishing tool (which takes a light depth of cut).

N. B.—This is an important item in the economical use of many of our tools.

**Speed.**

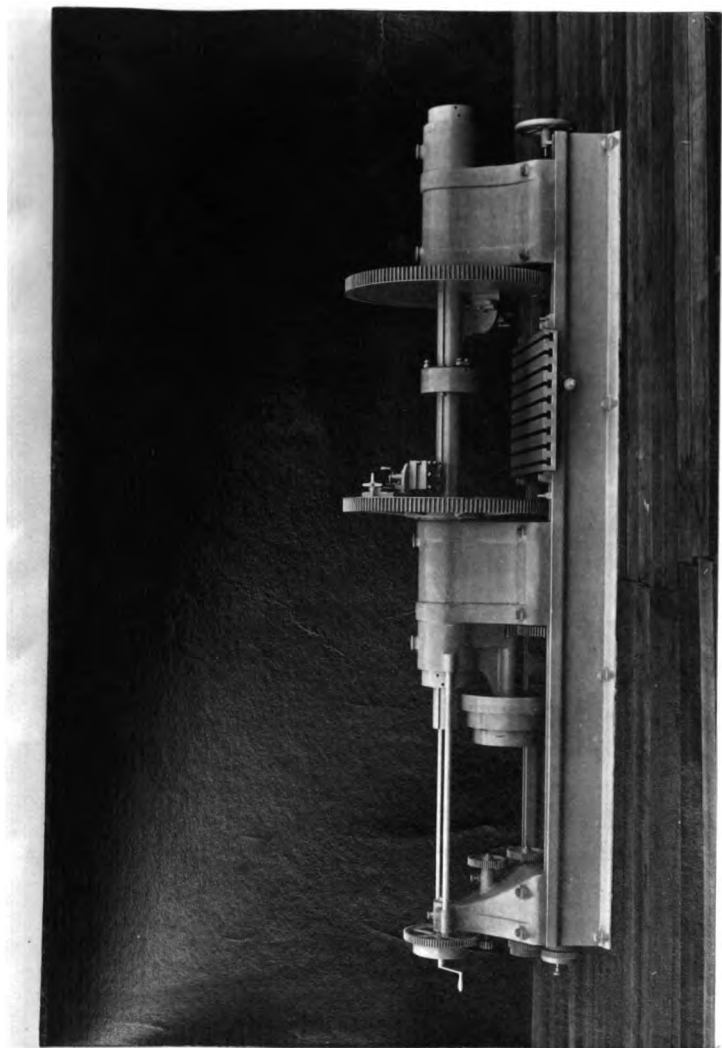
Counter-shaft of 84 inches and 120 inches mill, thus :

Fast and loose pulley on counter 22 inches diameter, 7 inches face, 80 revolutions per minute.





18    *CYLINDER BORING AND FACING MACHINE.*



## CYLINDER BORING AND FACING MACHINE,

For boring locomotive cylinders. Six-inch steel boring bar, driven at both ends of cylinder; independent slide rests for facing off both ends of cylinder; six changes of boring feed, with a quick hand for work to be shifted; cutter heads to bore from 10- to 22-inch, power return. Bar draws entirely out of cylinder, to allow the work to be shifted; cutter heads to bore from 10- to 22-inch cylinder. Iron cone pulleys turned inside, so as to be accurately balanced; over-head shaft, with ball and socket hangers and fast and loose pulleys, 18 inches diameter, 4 inches face, which should run 140 revolutions per minute. A full set of wrought iron wrenches. Wrought iron work case hardened.

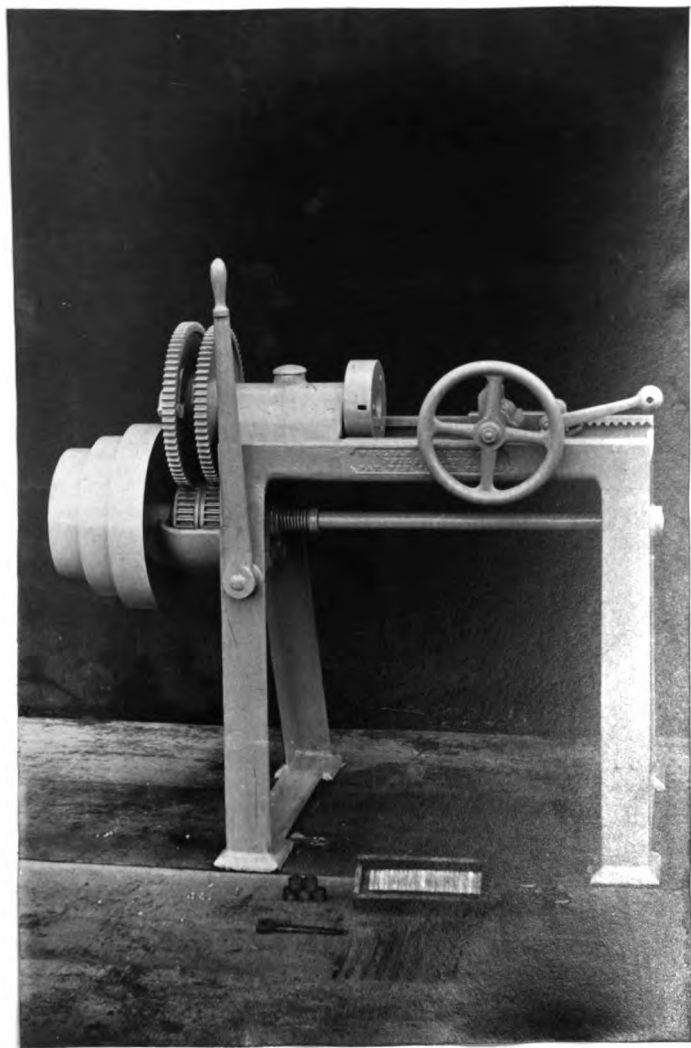
THIS is one of the most notable of the modern special tools; it was designed to bore locomotive cylinders, and is capable of boring and facing up the flanges, also counter boring for clearance of pistons at end of stroke of a cylinder of the largest size used in freight engines or express passenger engines, in three and a half hours. This is remarkable, when the quickest time ever known to have been made in the same work previous to the construction of this machine was *nine hours*; the usual time, however, being seldom less than thirteen hours on ordinary boring machines. In performing this work the same principle is brought into play as is mentioned in our notes on Boring Mills,—one cut with a fine feed takes out the greater part of the metal; while the roughing cut is being made, the sinking head is cut off by the face plate slide rests and the flanges turned up. Two finishing cuts are then run through with a feed  $\frac{1}{2}$  inch broad, and the cylinder counterbored at end afterwards.

Time taken  
on other  
machines.

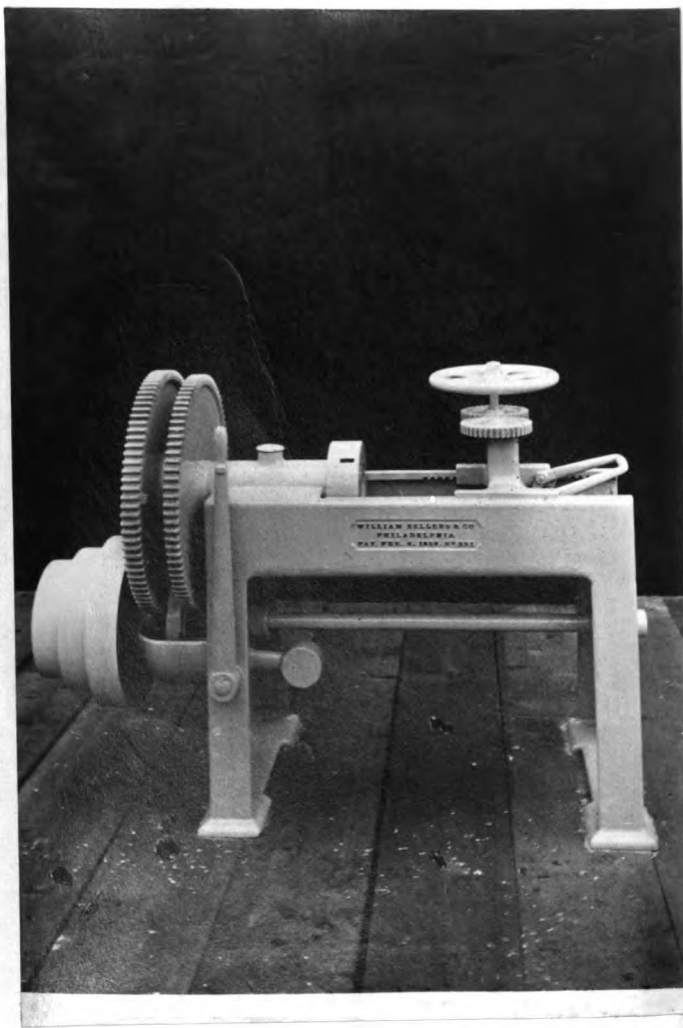
Nature of  
feeds.

## 20    *CYLINDER BORING AND FACING MACHINE.*

**Speed.**    In case of it being deemed advisable to turn the flanges up at a time when no cut is under operation, the increase of time still permits the work to be done in less than five hours to each cylinder. Fast and loose pulleys on over-head shaft, are 18 inches diameter, 4 inches belt, and should run 140 revolutions per minute. This will give speed of cut on 22 inches cylinder of 18 feet per minute.



**22 PATENT BOLT AND NUT SCREWING MACHINE.**



## PATENT BOLT AND NUT SCREWING MACHINE,

WITH IMPROVED DIE BOX, AND A FULL SET OF TAPS AND  
ADJUSTABLE DIES TO COMPENSATE FOR WEAR, WITH  
TAP AND NUT HOLDERS FOR THE RANGE SPECIFIED;  
OVER-HEAD SHAFT, PULLEYS, AND BALL AND  
SOCKET HANGERS COMPLETE; WROUGHT  
IRON WORK CASE HARDENED.

The advantages claimed for these machines over all others in use are—

1st. The dies revolve and the bolt is stationary, which enables the workman to put in a fresh bolt without stopping the machine, and on long bolts is much more convenient than to revolve the bolt.

2d. The motion of the dies is always in one direction, and the bolt is cut at one operation; the dies are open while they are revolving, consequently they leave no mark on the thread.

3d. The dies never run backward; the cutting edge will last much longer than when the motion of the die is reversed.

4th. The dies are adjustable, so as to compensate for wear.

5th. The dies can be changed without taking off any of the die-holding apparatus, and in less time than they can be changed in a common hand-screwing stock.

6th. The bolt holder is arranged so as always to chuck the bolts in the centre of the dies, thus insuring correct work when the bolts come to be put in their places.

Size of Machine.	Range of Cut.	No. of Taps sent with each.	Speed of Counter.	Size of Fast and Loose Pulleys.			
				Diam.	Face.		
					Loose.	Fast.	Loose.
$\frac{3}{4}$ "	$\frac{1}{4}$ " to $\frac{3}{4}$ "	8	200 rev's per min. in all cases.	12"	7"	4"	7"
1"	$\frac{5}{8}$ " to 1"	8		13"	7"	4"	7"
1 $\frac{1}{2}$ "	$\frac{3}{4}$ " to 1 $\frac{1}{4}$ "	8		14"	8"	4 $\frac{1}{4}$ "	8"
2"	$\frac{3}{4}$ " to 2"	8		19"	8"	4 $\frac{1}{4}$ "	8"
2 $\frac{1}{2}$ "	1" to 2 $\frac{1}{4}$ "	8		20"	8"	4 $\frac{1}{4}$ "	8"
3"	1 $\frac{1}{8}$ " to 3"	9		22"	8"	5"	8"
4"	1 $\frac{1}{2}$ " to 4"	9		26"	8"	5"	8"

IN these machines the bolts are cut as with solid dies, at one operation,—i.e. with once going over, but open under-cut when the work is done, and in releasing the bolt removes all trace of the chip made by the cutting tools. The specification above clearly expresses the advantages of the machine. On the back of the large driving wheel is an index or pointer, which must be set to numbers given on a card sent with each machine. When so set, the bolt will fit a nut of corresponding size cut with the tap sent with machine. An adjustment of the index, one way or the other, will cause the bolt cut to be larger or smaller, thus permitting the thread to be adapted to the use required of it, and also permitting an adjustment of dies to compensate for wear. This machine is made and used extensively in England and on the Continent, and is believed to have no equal in durability and efficiency.

These machines are fitted with dies for cutting V threads only, and, when not otherwise specified, we furnish taps and dies corresponding with the so-called American standard, which was recommended for general adoption by the *Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts*, at a meeting held December 15, 1864, and which is expressed in the following resolution :

Index on back  
of driving  
wheel.

Adjustment of  
size of bolt.

Use abroad.

V threads.

American  
standard.

Franklin  
Institute  
thread.

*Resolved*, That the Franklin Institute of the State of Pennsylvania recommend, for general adoption by American engineers, the following forms and proportions for screw threads, bolt heads, and nuts, viz. :

That screw threads shall be formed with straight sides at an angle to each other of  $60^{\circ}$ , having a flat surface at the top and bottom equal to one-eighth of the pitch. The pitches shall be as follows, viz. :



Diameter of bolt...	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$
No. threads per in.	20	18	16	14	13	12	11	10	9	8	7	7	6	6	$5\frac{1}{2}$	5	5
Diameter of bolt...	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6
No. threads per in.	$4\frac{1}{2}$	$4\frac{1}{2}$	4	4	$3\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{4}$	3	3	$2\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{5}{8}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{3}{8}$	$2\frac{3}{8}$	$2\frac{1}{4}$

The distance between the parallel sides of a bolt head and nut, for a rough bolt, shall be equal to one and a half diameters of the bolt, plus one-eighth of an inch. The thickness of the heads, for a rough bolt, shall be equal to one-half the distance between its parallel sides. The thickness of the nut shall be equal to the diameter of the bolt. The thickness of the head, for a finished bolt, shall be equal to the thickness of the nut. The distance between the parallel sides of a bolt head and nut, and the thickness of the nut, shall be one-sixteenth of an inch less for finished work than for rough.

Proportion for  
nuts and bolt  
heads.

We can adapt dies for cutting coarse-threaded wood or "lag" screws, and so also dies for cutting square threads; in case of the latter, it is advisable to make the cut with more than once going over, to produce smooth work. Unless specially ordered to the contrary, our machines are always adjusted to cutting threads to standard diameters, and iron used in bolts should be swaged down on part where screw is to be cut to the proper size.

Wood screws  
and square  
threads.

Cuts to stand-  
ard diameter.

The counter-shafts of our bolt cutters are made with two loose pulleys, one on each side of a fast one, so that open and crossed belts can be used to run the machine backwards as well as forwards. This running backwards is only of use in recutting dies, or cutting left-handed screws. To sharpen the dies, they must be softened, and then recut with hobs, which we make for this purpose, but which are not included in the price of the machine, inasmuch as when more than one machine is in the same shop one set of hobs and

Counter-shaft.

Recutting  
dies.

Hobs for re-  
cutting.

Collars sent  
with hobs.

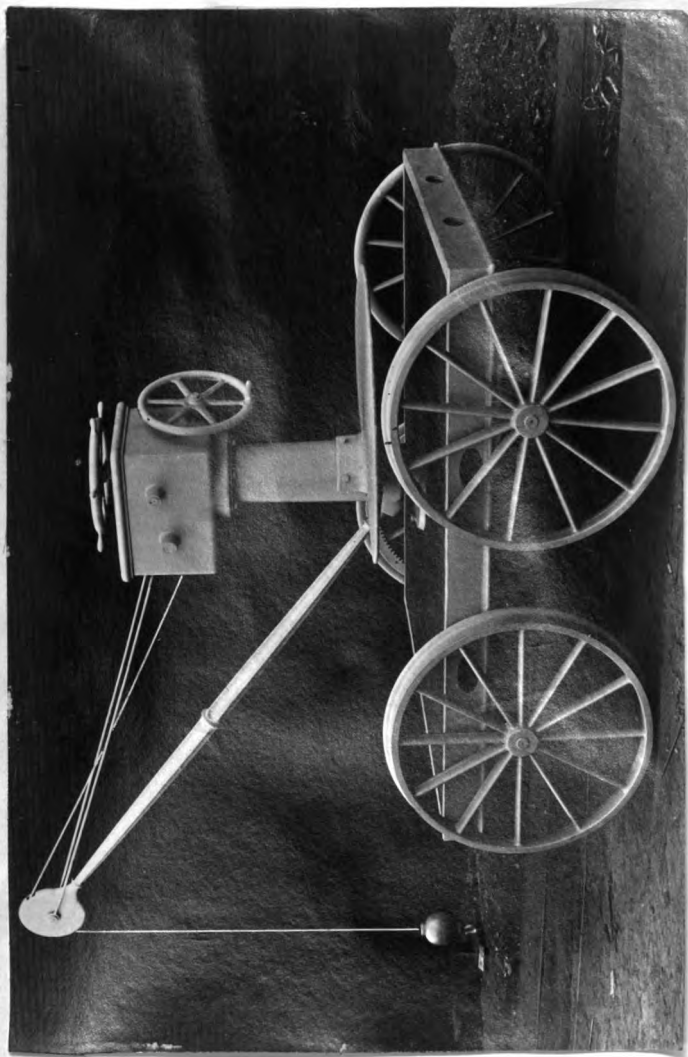
collars will do for them all. The hobs are guided in recutting dies by collars fitting in hollow sleeve, and guiding a prolongation of one end of hob, while the other end is held in the clamp for holding the bolts to be cut. This insures perfect concentricity to the dies. It must be borne in mind that in the use of

Use animal oil  
only.

bolt cutters oil should be freely used upon the work, and the oil used should be *animal*, not from *coal*. The commonest lard or fish oil will answer a good purpose.

With each machine we send full printed directions for setting the dies and for repairing them.





## MOULDING CRANE,

With cast iron bed plate 9 feet 3 inches square, mounted on four wheels 48 inches in diameter; the gauge of track upon which it is to run being 9 feet 10 inches. Radius of jib swing, 11 feet 7 inches; distance from top of rail on floor to sheave at end of jib, 10 feet; hoisting machinery so arranged as to be self-sustaining, thus avoiding all danger of running down; platform for operator attached to centre post, from which position the load can be hoisted and the carriage moved upon the track. The whole complete with wire rope, and ball hook.

**A** VERY convenient crane for use in foundry for moulding car wheels, or similar work; will answer for weights of 1000 pounds. The wheels upon which it is carried, being 48 inches diameter, admit of its passing over flasks 22 inches high, above the rail.

## CRANES FOR FOUNDRY PURPOSES,

With cast iron base and top plates; double set of gearing upon the base plate, so as not to be affected with the straining or shrinking of the timbers; top sheave frame iron, arranged to move the whole length of jib by means of a chain wheel near crank shaft; sheaves bushed with steel and revolving upon steel pins; ball and socket hook; the whole complete, with all necessary chain, wire rope, bolts for timber work, and rails for top sheave frame.

5, 10, 25, and 50 ton crane.

**A**N important feature in these cranes is the arrangement of the jib and over-head carriage.

Instead of making the jib horizontal, and carrying the hoisting chain from extreme end of jib over the sheaves, and thence back, over a sheave near the post, to the drum, we carry the chain from drum direct, diagonally to the carriage, and make the end fast to the lower block; then, with three upper and two lower sheaves, we hang the load on five strands of chain, instead of on four, as is usual, and thus work with much less friction. We drop the jib towards its end, so as practically to make the load more level in running it out and in. This enables one man to run the carriage and load, either out or in, with ease and dispatch.

Load on five  
strands of  
chain.

Two powers to  
machine.

There are two powers to the machine, and a means of shifting quickly from the one to the other, or to lock. We have patterns suited to 16 feet, to 25 feet, and also to 31 feet, height of room. The latter patterns are the most recent, and have several important features. They are capable of winding up a large amount of chain, so as to work in a room 31 feet

high without having to override the chain on the Chain on drum.  
drum.

We have also adapted a patent brake to these large Patent brake.  
cranes, which enables the load to be held in any position, and lowered by friction, without danger to the workman.

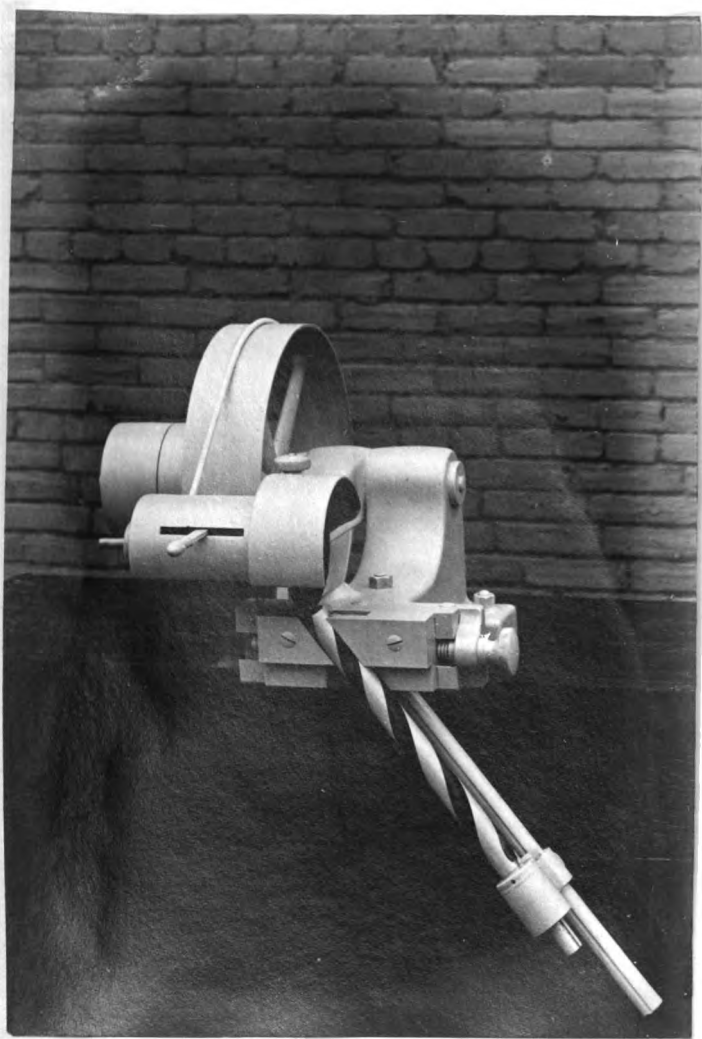
## CUPOLAS FOR FOUNDRY PURPOSES,

With cast iron foundation plate supporting the columns which carry the cast iron base plates and doors for discharging waste contents, after heat; wrought iron case, wind chambers and valve, charging door and elbow to chimney so arranged as to deposit all the cinder at base of chimney. The whole fitted complete, with fire brick ready for lining the curved portion immediately above boshes.

Diameter of boshes: 24, 30, 36, and 42 inches.

**A** VERY excellent form of cupola, simple in construction and giving a good result in melting.

The interior is of a shape to hold the lining with certainty, and to permit the placing of the tuyeres in any required position in the circle and of any number.





## DRILL GRINDING MACHINE,

Arranged to grind twist and fly drills, making cutting edge of uniform angle and length, thus insuring equality of cut upon both sides. Shank of drill held in chuck, and lip of drill held in jaws, so that cutting edges will revolve perfectly true in the drill press. Fast and loose pulleys on machine, 6 inches diameter, 3 inches face, which should run 500 revolutions per minute. Wrought iron work case hardened.

AS part of our system of shop management and economy, stress should be laid on this tool. By means of it, twist or fly drills may be ground or sharpened readily, and in such a manner as to insure the cutting lips being equal and of proper angle and clearance in cut. This machine, to be efficient, should be placed in the hands of some one man whose business it is to sharpen all drills used in the establishment. Any well-regulated shop should have a tool room, in which all the small tools required by workmen, such as drills, reamers, taps, mandrels, gauges, etc., are kept, and can be given out to the workmen to use, to be returned when done with or when needing sharpening. This system will diminish the quantity of tools required to carry on the business, over the more shiftless way of allowing each workman to keep all the tools required on his special work. The shape of the cutting edges obtained by the use of this machine is such as to give the best possible condition for cutting under all circumstances of quality of material. The fast and loose pulleys on the machine are 5 inches diameter, 2½ inches belt, and should make 500 revolutions per minute. The grinding wheel sent with the machine is made of emery, and will with care last several years in constant use.

Tool room.

Shape of lips.

Emery wheel.

## HORIZONTAL DRILLING AND BORING MACHINE FOR CAR BOXES, ETC.,

With self-acting variable feed to drilling spindle, bed flat top as in lathes, without adjustable table, especially adapted to boring car boxes and any work held in special holders; over-head shaft with ball and socket hangers and fast and loose pulleys, 14 inches diameter, 4 inches face, which should make 80 revolutions per minute.

Iron cone pulleys turned inside, so as to be perfectly balanced; full set of wrought iron wrenches. Wrought iron work case hardened.

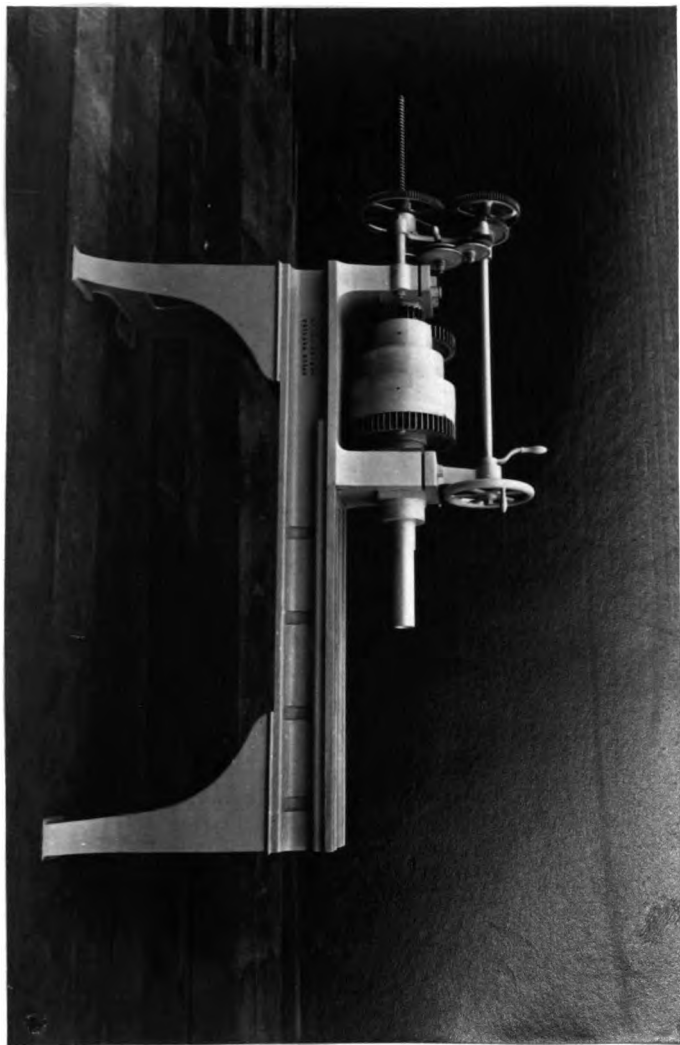
**T**HIS machine is in principle the same as our Larger Horizontal Drill, but is not provided with adjustable tables for the work to rest on.

The prolongation of the bed or shears beyond the boring head is provided with slots for bolts to enable devices for holding special work to be readily bolted to place. It is used extensively for boring all kinds of car boxes and similar work. In any case where there is a repetition of boring on the same kind of work it has great advantages. As, for example: In the manufacture of the Westinghouse Air Brake, these machines are used exclusively to bore all the cylinders not only of the pumps but of the air cylinders, say 10 inches or 12 inches diameter, which are placed under the car. In our own shop we find it of great use in brass shop, and we use a number of them for boring hangers, hanger boxes, and couplings for our shafting.

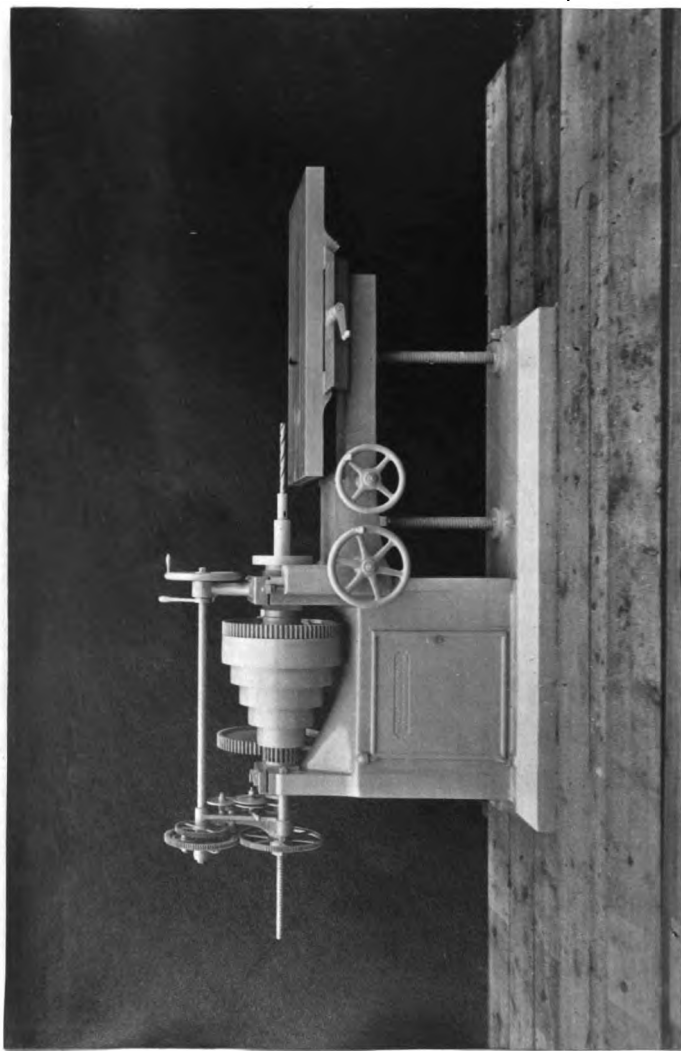
Example of  
use.

Speed.

Fast and loose pulley, 14 inches diameter, 4 inches belt, 80 revolutions per minute.



36 *HORIZONTAL DRILLING AND BORING MACHINE.*



## HORIZONTAL DRILLING AND BORING MACHINE,

With patent variable feed and quick hand traverse to boring spindle, arranged so as to be changed instantly from one to the other; compound tables arranged to move vertically, with horizontal movement at right angles, and parallel to drilling spindle; arbor which carries drilling spindle arranged with face plates so that the machine can be used as a face lathe; over-head shaft; iron cone pulleys turned inside so as to be perfectly balanced; ball and socket hangers, and a full set of wrought iron wrenches. Length of traverse to drilling spindle, 24 inches. Diameter of piece will swing over table, 51 inches. Wrought iron work case hardened.

Extra slide rest to bolt on face plate for squaring pipes or facing off work.

**T**HIS machine, designed to bore and drill work horizontally, resting upon a table or platform, has been considered by some eminent engineers as coming next to the lathe in usefulness in the shop. It will drill work that could not be operated upon in an ordinary drill press, and has all the advantages of a facing lathe for some kinds of work.

The counter-shaft has 16 inches fast and loose pulley, Speed. 4 inches face, which should make 75 revolutions per minute.

A marked advantage which this machine has over Advantages. similar tools of other makers, is in the nature of the feed motion, which, by use of the friction feed discs, admits of an infinite change of feed between its finest and its coarsest feed, in the ready application of the feed, and its quick hand motion; also, in the manners of operating the compound table upon which the work rests, the handles to govern the motion of table being all on one side, and within easy reach of the workman.

**Foundation.** The screws which raise the table require holes in the foundation below the bed, as when the table is lowered they project below the base of machine. If placed in damp places, the boxes or recesses in foundation for these screws should be made water-tight.



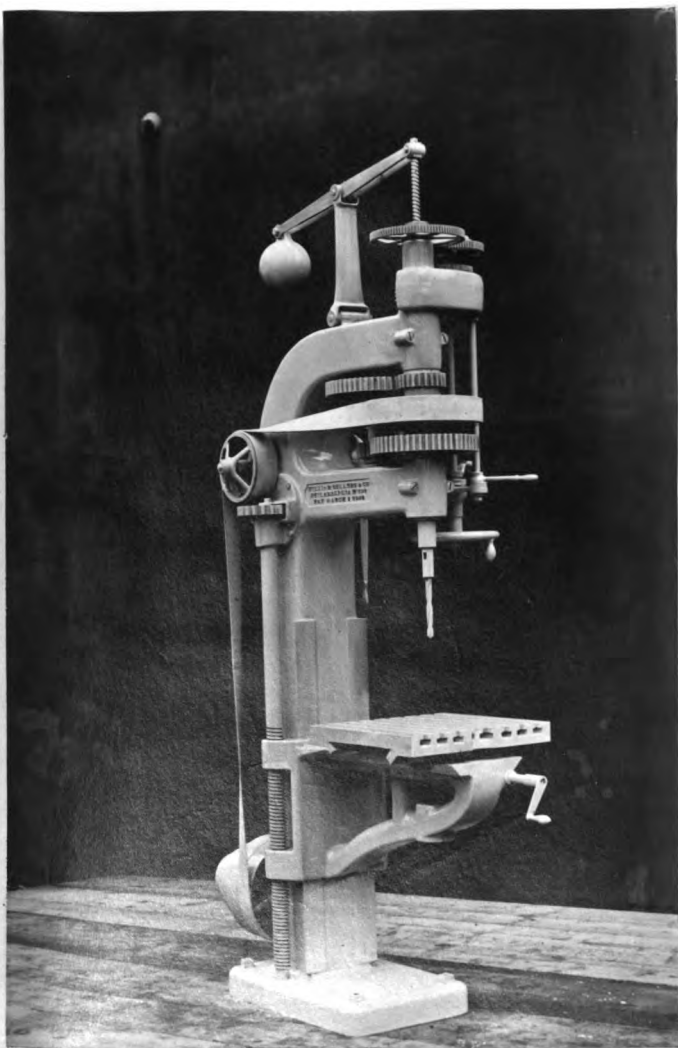
### 36-INCH VERTICAL DRILL.

Spindle of best cast steel, driven by belt only, and counterbalanced. Feed by hand only; has an overreach of 18 inches. Plain table, adjustable by rack to any required height. Fast and loose pulley on counter-shaft 12 inches diameter, 4-inch face; should make 110 revolutions per minute. Wrought iron work case hardened.

**Cone pulley.** THE acknowledged advantages of driving drills by belt, in preference to the usual bevel gearing, have led us to adapt this principle to all our vertical drills. This one is designed to fill the want for a plain, inexpensive tool for miscellaneous drilling, and is adapted to holes in cast iron up to 1½ inches diameter. The cone pulley is at base of the square post which forms the frame of the machine, and from it a belt passing over carrying pulleys actuates the drill spindle. Owing to the smoothness of the motion imparted by a belt, more and better work is accomplished, more particularly when small holes are being drilled. In the use of machines driven by belt when running at high speed, the absence of all rattle and noise is of itself a high recommendation.



40     *PATENT DOUBLE-GEARED VERTICAL DRILL.*





## PATENT DOUBLE-GEARED VERTICAL DRILL,

With square column, plain or compound tables, raised and lowered by screw, and arranged to swing to one side. Knee carrying table is provided with a bearing to hold lower end of boring bar. Drill spindle counterbalanced with quick hand and variable power feed, always in gear, but not interfering with the rapid movement of spindle vertically by hand. Spindle best cast steel; driving pulley on the spindle, so that when back gear is not in use the spindle is driven by belt only, *producing a particularly smooth motion for small drilling*. Cone pulley is at base of column, admitting ready change of speed; over-head shaft furnished with fast and loose pulleys, and ball and socket hangers; cone pulleys turned inside so as to be accurately balanced; a full set of wrought iron wrenches. Wrought iron work case hardened.

45-inch vertical drill,  $22\frac{1}{2}$  inches from centre of spindle to face of column, with plain table.

45-inch vertical drill,  $22\frac{1}{2}$  inches from centre of spindle to face of column, with compound table.

54-inch vertical drill,  $27\frac{1}{2}$  inches from centre of spindle to face of column, with plain table.

54-inch vertical drill,  $27\frac{1}{2}$  inches from centre of spindle to face of column, with compound table.

**T**HIS machine for holes of  $1\frac{1}{2}$  inches and under in cast iron has its spindle driven by belt only, but is provided with back gear to be used for heavier work. This belting system has been found to work much better than the geared plan of driving in common use; and in practice we find that in comparison with machines of otherwise similar capacity and power of cut, the same workman can do 15 per cent. more work on this machine than on the old styles. In an experiment with small drills, the power feed was used in boring a  $\frac{1}{4}$ -inch hole through 3 inches thickness of wrought iron successfully, and in less time

Driving by  
belts.

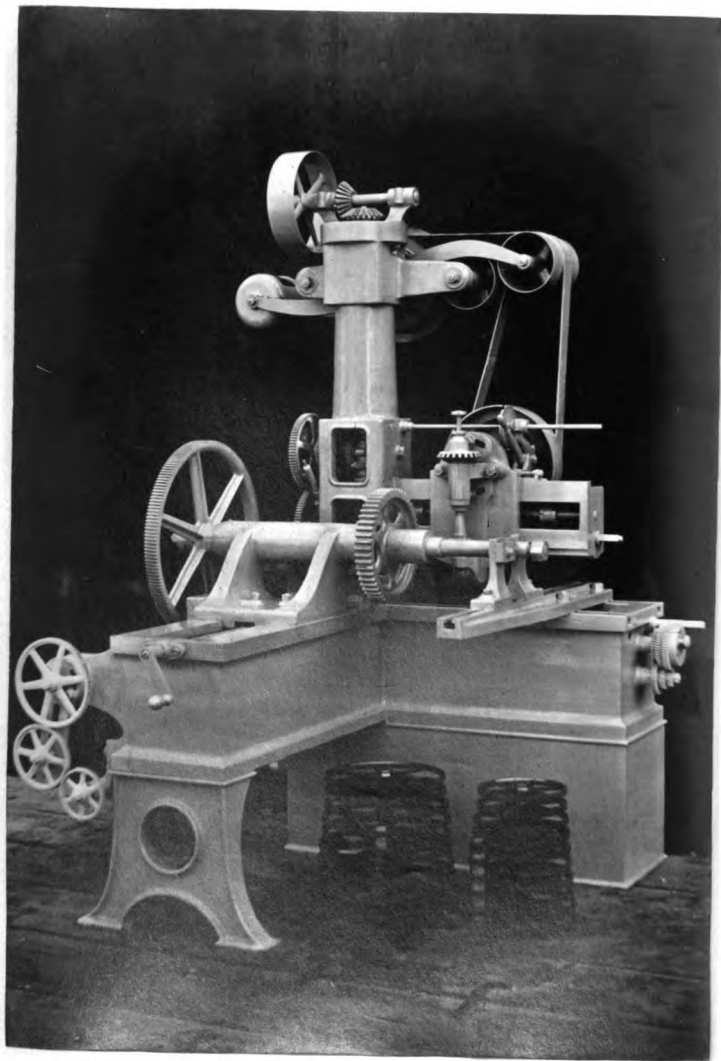
## 42    *PATENT DOUBLE-GEARED VERTICAL DRILL.*

than the same hole was made by a skillful workman feeding by hand.

- Post.**            The supporting post of this machine is square, and the bracket carrying the compound table is gibbed on to a plain surface. The raising and lowering of the
- Table.**            table are effected by a screw placed at one side of post in such a position as to enable the table to swing about it as on a hinge, after slacking the shoe on the opposite side of the bracket. This enables the table to be removed readily for the introduction of such work as can more conveniently rest on the floor.
- Raise table by power.**    The raising screw is driven by power, so as to give the utmost facility of adjustment. We make this tool with plain table, when required, but in the majority of instances in which purchasers have selected the plain table they have afterwards ordered the compound table to be adapted to them, the latter presenting so many advantages. In order that the tool may be used for boring purposes with double-ended cutter up to the capacity of the power, with the back gearing in use, we arrange in the bracket a hole to carry a guide bushing to support the lower end of the boring bar and to give steadiness to it undercut. On counter-shaft there are 10 inches by 4 inches fast and
- Guide for bar in bracket.**
- Speed.**            loose pulleys, making 110 revolutions per minute.



44 *GEAR CUTTING AND WHEEL DIVIDING MACHINE.*



## GEAR CUTTING AND WHEEL DIVIDING MACHINE,

Automatic in all its motions; arranged to cut bevel and spur wheels to 4 feet 6 inches diameter and 9 inches face. Division made by wheel and tangent screw carefully constructed. One full set of change wheels to effect division of wheels from 10 up to 360 teeth. Feeds self-acting and variable.

**T**HIS machine is arranged for cutting both spur and bevel wheels, has a capacity up to 54 Capacity. inches diameter of wheel, 9 inches face, and will cut a number of small spur wheels of same size at one time. It is entirely automatic, performing all its work after adjustment, without attention of workman, to the completion of the wheel being cut or divided. The division is obtained by a tangent wheel and worm Mode of divid-  
ing. very carefully constructed, and the designated number of teeth is obtained by use of change wheels (a full set of which accompanies the machine), and the turning of the handle for change 1, 2, or 3 times, as may be called for on the schedule of division. This turning of the handle, however, and all other motions, are done by the machine itself. Thus, a blank wheel being put in place and the proper cutter adjusted to depth of teeth, length of stroke of cutter head, etc., the cutter will pass across face of wheel, cutting space between two teeth, will then return at a quick pace to the starting side of wheel, the blank will then be turned to present a second space to be cut, and the cutter will start its proper motion, all by the machine itself, not of the attendant workman. To forcibly illustrate the merits of this machine, it may be said that in method of dividing, speed and power of cut it

Quantity of  
work done.

does not materially differ from other well-made gear cutters, but in quantity of work done, one machine has been found, on similar work, to do one and a half times the work done by a skillful man on a gear cutter operated partially by hand. In practice one man can advantageously attend four of these machines; each machine doing much more work than a hand machine, and really using but one-fourth of a man's time. Too much stress cannot be laid upon this as an example of labor-saving machine tools, and as an argument in favor of such tools over those usually made and sold. Counter-shaft has 14 inches fast and loose pulley, 4 inches face for  $3\frac{1}{2}$ -inch belt; 120 revolutions per minute.

Speed.

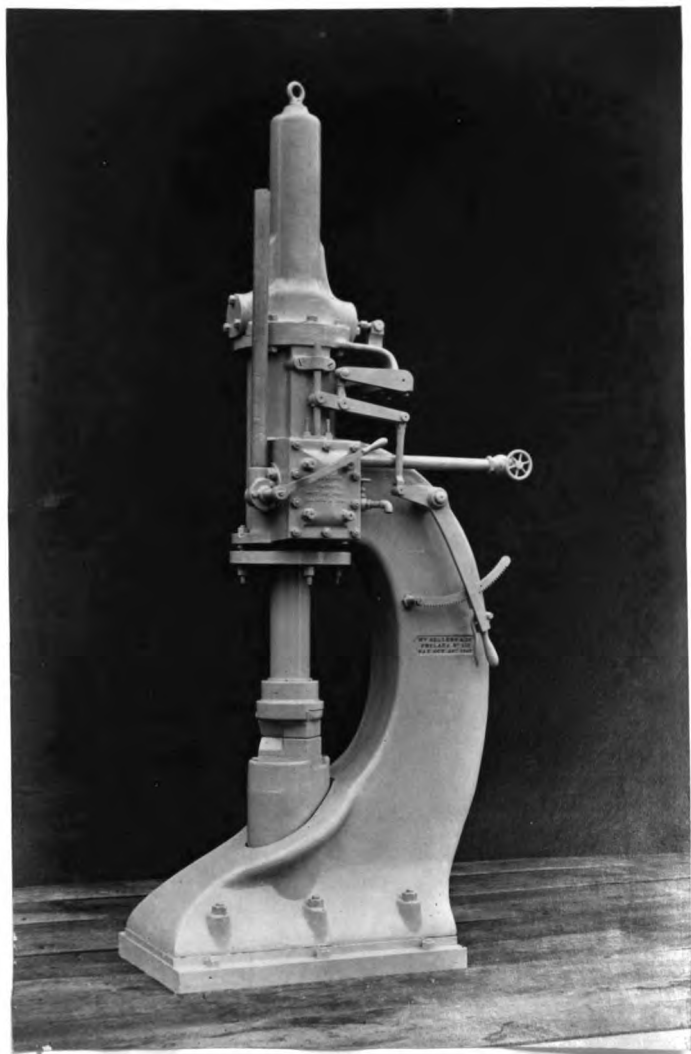
### GRINDSTONE BOXES,

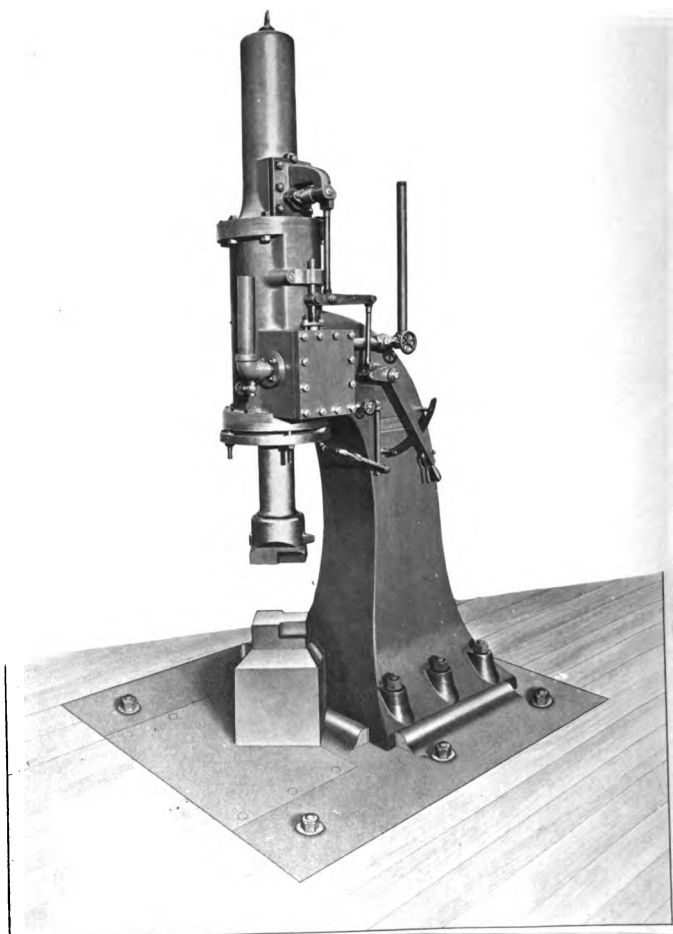
With shaft and ball and socket bearings complete; the whole fitted to run upon wheels. Pulleys and grindstones extra

To swing 42-inch stone. 6-inch face.

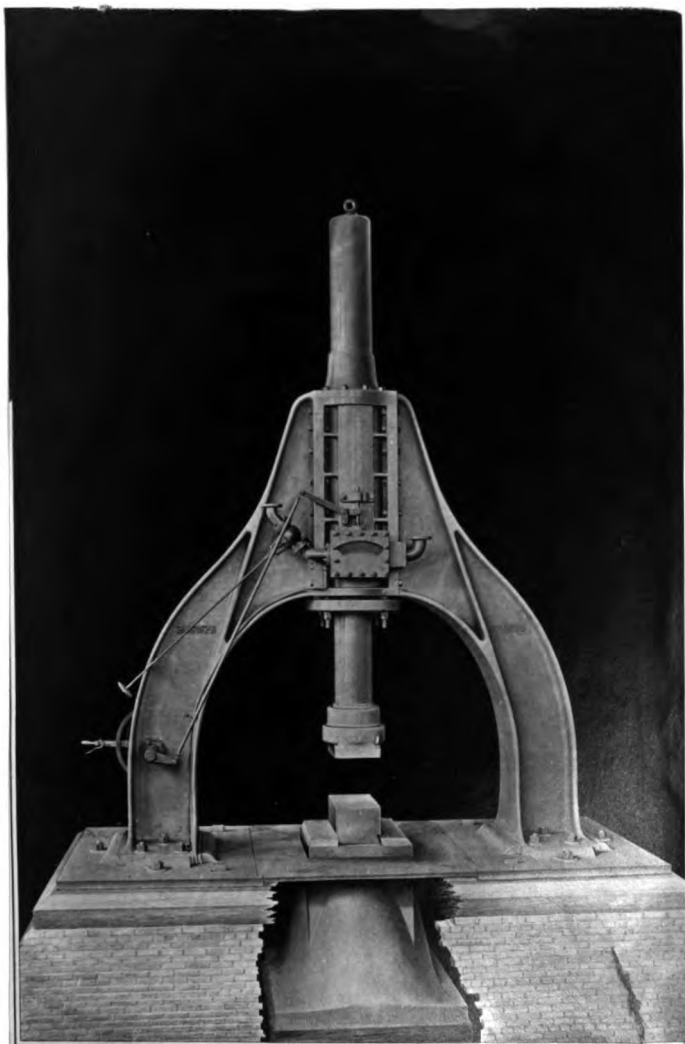
" " 48 " "  $7\frac{1}{2}$  " "

THESE boxes are of cast iron, in one piece, resting on three wheels, one of which is made to turn in a socket, for ease of moving the box to place. This arrangement permits the box to be run under a crane for putting stones in place, and when placed in proper position, the front wheel being turned at right angles to the others, holds the box stationary against the pull of the belt, at the same time, by moving the box, permitting the same belt to be used, without cutting, for large and small driving pulleys as the stone wears down and requires speeding up. When required to furnish pulleys, we select such sizes as will in use keep the stone up to speed as it wears.









## STEAM HAMMERS.

### SIZES.

Size or Weight of Hammer Ram.	Length of Stroke.	Height under Frame.	Width between Frames.	Hammer Face.
300 lb.	15½"	SINGLE UPRIGHT.	SINGLE UPRIGHT.	63"×4½"
650 "	18"			8½"×5½"
1000 "	20"			9"×5¾"
1500 "	23"			10½"×6"
2000 "	27"			11¾"×7"
2500 "	31"			13½"×9"
1½ ton.	3'	5' 9"	7' 4"	16½"×9½"
2 "	3' 4"	6' 0¾"	7' 10½"	17¾"×10"
2½ "	3' 9"	6' 6¾"	8' 9"	19½"×12"
3 "	4' 2"	7' 0¾"	9' 0¾"	21½"×12½"
4 "	4' 6"	7' 5¾"	10' 6"	23"×14"
5 "	5' 3"	8' 4½"	12' 3"	26½"×16"
7 "	6'	9' 4"	14'	29½"×18"

### GENERAL SPECIFICATION.

Piston rod or hammer bar of solid wrought iron, passing through both heads of cylinder; piston head forged solid with piston rod. Hammer head adjustable on lower end of bar; bar prevented from turning by upper cylinder head. Slide valve balanced.

Hammers of 2500 lbs. weight and under have one upright only, are double acting, taking steam above and below the piston, with self-acting valve gear and hand motion operated by the same lever: can be changed at will whilst in operation, thus affording complete control over the length, rapidity, and force of blow; also, enabling

the hammer to be used as a vice or squeezer. 1000 lbs. and under have anvil block passing through the base of upright. Hammers of 1500 lbs. and under are provided with a means of throttling the exhaust below the piston, so as to enable the blow to be diminished in intensity without materially decreasing the rapidity of motion. This attachment is of the utmost importance in finishing light work or tilting steel. All hammers over 2500 lbs. weight have double uprights and are hand-working only, taking steam above and below the piston, thereby increasing the force and rapidity of blows.

IN our introduction into this country of the "Morrison Steam Hammer" we were influenced by what seemed, in our judgment, the practical advantages of his system over all others then known. During the many years we have been making these machines, our attention has been constantly directed towards improving the mode of construction and increasing their durability and efficiency. The essential peculiarities of Mr. Morrison's system were in making the part which strikes the blow—that is, the hammer Solid bar.—of one long bar of wrought iron, having the piston welded to and forming part thereof, and guiding this bar by the top and bottom cylinder heads only, thus doing away with the usual side guides in the hammer No side guides. frame, leaving the entire space below the cylinder free for the use of the workman in handling his work, whilst the hammer head and die is guided more efficiently than in any other system, and the frames are subjected to less strain.

These hammers, as first constructed, had a uniform diameter of bar above and below the piston, with an enlargement at the lower end, in which enlarged part the dovetail for holding the dies was planed. The upper end of the bar—i.e. the part above the piston—was planed flat on one side, to keep the bar from Flat on top end of bar. turning. In practice, it was found that hammers

Liability to  
break.

made with this uniform diameter of bar and solid hammer head would in time give out immediately above the enlarged part of the bar at the lower end, because this is the place where the accumulated concussive force is intensified, resulting in some instances in fracture.

Increase of bar  
below piston.

Proceeding on the theoretical idea that in a bar of iron used as a battering ram, the mass of metal forming the ram should increase in sectional area towards the point of impact, has led us to make the diameter of the piston rod or ram greater below the piston than above it, thus bringing the greatest mass of metal nearest the point of impact, and proportioning the parts so as to be better able to withstand the strain incident to each part.

Loose hammer  
head.

This change, while it made a very decided improvement in the durability of the bar, rendered possible a more important change,—viz., the attaching a loose hammer head, of the requisite size, to the lower cylindrical end of the hammer bar, by means of a circular taper key. Fastening the hammer head by means of this circular key has entirely done away with the possibility of breaking the bar by concussion. As now arranged, the force expends itself at the extreme end of the ram, in contact with the die face, and produces no other result than is attainable by hammering on this part,—i.e. on a surface great enough not to be burred up.

Increased  
durability.

While this system of loose head insures the durability of the hammer bar, it also permits the setting of the dovetail in any required position in regard to the anvil block, and admits of a ready repair of the part which holds the top die, if injured by careless driving of keys, etc. In reference to the keys used

in holding dies, it will be found that each machine sent out from our works has its die held by means of a crimped steel key, which is of uniform thickness (not made taper), and which holds the die with an elastic pressure. We recommend the use of this form of key in preference to any other, care being taken to re-bend when they become loose by use.

Use of crimped key.

In our automatic hammers the motion to work the valve has been obtained from a diagonal groove in the upper end of the hammer bar. In early practice this diagonal groove was planed in the flat surface, which surface Mr. Morrison recommended as a means of

Diagonal groove.

preventing the bar from turning; but as this slot so made was found to cause a slight tendency to rotate the bar back and forth, it has been abandoned, and inclined grooves, diametrically opposite to each other, are made to work a brass yoke, whose

Inclined grooves.

line of vibration is through the central axis of the bar, thus entirely obviating the above objection, and very much increasing the extent of wearing surface, and permitting the guiding of the bar by brass keys in these opposite grooves. The simplicity of the valve motion in all our recent steam hammers recommends its use. Apart from this, we have modified the ports

Valve motion.

in the steam chest, so as to use a supplemental valve to throttle the exhaust below the piston, without impeding the free exhaust above the piston. This enables the hammer to strike quick, light blows for finishing; in other words, the hammer can go up as quickly, but in coming down its force may be gauged by the steam cushion upon which it descends, which steam, thus condensed in bulk, re-expands in the up stroke, to the manifest economy of steam used. To

Choking exhaust below piston.

Light quick blows.

fully appreciate the importance of this improvement, it

must be borne in mind that any attempt to gauge the intensity of the blow by throttling the ingress of steam to the cylinder, slows down its speed and renders its automatic blows irregular without proportionately decreasing their force, as in many cases the weight of the bar alone is too great for the character of work in progress. We cannot too strongly recommend this recent feature in our improved hammers, which is placed upon all hammers of 1500 lbs. weight and under, such hammers being more often required to do both light and heavy work than the larger sizes.

Balanced  
valve.

Hand lever.

Steam on top  
of piston.

In explanation of the efficiency of the valve motion as used by us, it must be borne in mind that the easy sliding balanced valve, obtaining its motion from the hammer bar, as above shown, is readily shifted upon the ports by the working lever and the length of stroke varied at will by the operator. In addition to this, if the working lever be moved by hand, in such a manner as to accord in time with the automatic stroke, the force of the blow is intensified to the extent of following the hammer bar down to the work with a full port open below for exhaust, and a full port for ingress of steam open above; in other words, the full force of the steam acts down through the entire stroke, adding to the weight of the bar the force of the steam, at whatever pressure it may be carried, acting over the whole piston area. It must be manifest to the most casual observer that the hammer bar as used in these hammers, in one solid mass of wrought iron, must be better adapted to the use of this steam force, to drive down, than are those hammers in which a cast iron "tup," or hammer head, sliding in side guides, is raised by means of a piston rod and piston attached to its upper end, and in which the down

pressure of steam can only be exerted through the comparatively small diameter of piston rod.

A slow motion of the working lever will permit a corresponding slow raising of the hammer and its slow descent, with a squeezing force upon the work, so that it permits its advantageous use as a squeezer for bending and holding work between the dies, and in large hammers, when used for hammering puddled balls, it enables the loose ball to be pressed or squeezed into a compact mass before being hammered. In short, the

Use as a  
squeezer.

valve motion with the one working lever enables the workman to have as perfect control of the rapidity, force, and character of the blow as is possible with a hammer held in his hand and controlled by his will.

Control of  
hammer.

Hammers up to and including 2500 pounds weight of ram are made with one upright only; those of 1000 pounds and under are so made as to inclose in their base the top of the anvil block, which block rests on a separate foundation, and thus relieves the frame from shock.

One upright.

The larger sizes of hammers, over 2500 pounds weight, are rated by tons, not by pounds, and are made with double uprights spread wide apart, and admitting of great ease of manipulation on the part of the workman. The cylinder is firmly bolted between these uprights, which, from their peculiar form, act as efficient braces to hold the cylinder firmly in position. The

Double up-  
rights.

valve chest is placed on the back of cylinder, allowing the crane to swing up close to it, without any possibility of striking the valve gear. The working boy stands on the front of the machine, upon the floor level, not on a raised platform, thus enabling him to more certainly gauge the height of blow. In these double upright hammers the valve motion is not automatic, it

Valve-chest  
back of cylin-  
der.

By hand only.

Foundation  
plates.

Anvil.

having been found that hand-working hammers are more convenient for the use to which they are applied. The uprights of the hammers are bolted to extended foundation plates, these plates in turn resting on and being secured to the foundations, with an intervening layer of timber to give more elasticity. The anvil block rests on a separate foundation, with layers of wood under it for the same purpose. In reference to weight of anvil block, it is usual to make its weight, when used for hammering iron only, about five times the nominal weight of hammer; thus, for a two-ton hammer, the anvil block should not weigh less than ten tons; but when used for hammering steel, it has been found advantageous to make the anvil block heavier,—say from seven to eight times the weight of the hammer. It is not essential that this extra weight be obtained in one solid block; it is as well to add weight by placing under the regular anvil block a wide-spreading under plate of the requisite additional weight.

Nominal  
weight.

In speaking of the nominal weight of these hammers, it must be borne in mind that we rate our hammers by the actual weight of the hammer bar, not by the force of the blow. It is necessary to note this, inasmuch as some makers rate their hammers by some assumed force of blow they are presumed to be capable of striking. Thus, our 1½ ton hammer has a hammer bar weighing 1½ tons. We do not indicate what its force of blow is,—such force being dependent upon many considerations, such as thickness of work being acted on, softness of material, and pressure of steam. We emphasize this, because this difference in mode of rating leads to wrong conclusions on the part of inquirers, who may think the price of our 1½ ton hammer high, as compared to



the price of some other maker's  $1\frac{1}{2}$  ton hammer, which, in point of fact, may be a five-hundred pound hammer, striking, it is assumed, a  $1\frac{1}{2}$  ton blow.

In confirmation of the merits claimed for our method of constructing steam hammers, we annex copies of two letters received on the subject.

BLACK DIAMOND STEEL WORKS, PARK, BROTHER & Co., }  
PITTSBURGH, May 25, 1871.

MESSRS. WILLIAM SELLERS & Co., Philadelphia:

GENTLEMEN,—We have in use at our works *two* of your *Steam Hammers*. Both of them are of your *fifty-five hundred-weight* size; but, owing to the weight of dies we are using, we call them "*Our Three-Ton Hammers*."

The first of these we bought from you January 16, 1863. Soon after its receipt we put it to place, and ever since then it has been almost constantly in use—a part of the time on double turn—in forging heavy cast steel shafts and shapes.

The second Hammer was delivered to us October 31, 1865. This one has been in constant use in hammering our own make of iron into the shape of blooms.

We may say that, with the exception of some trifling repairs, these Hammers have not in any way given out, and are to-day about as good as new.

Your Steam Hammers, owing to their plan of construction, are admirably adapted to withstand the straining shocks to which all steam hammers are subjected.

The plan of construction of your *frames*, and the method adopted for fastening the *cylinder* thereto, cannot, in our opinion, be improved.

By abandoning the old plan—which is, we think, in use on all other makes of steam hammers—of working the head in the frame, and instead thereof working it as one piece with the rod, in and through the cylinder, you relieve your frames from the constant straining shocks they would otherwise be subjected to.

We know of no other make of Steam Hammers now in use equal to yours, and take pleasure in testifying to their superiority.

Respectfully yours,

PARK, BROTHER & CO.

THE BESSEMER STEEL WORKS,  
TROY, N. Y., March 20, 1871.

MESSRS. WM. SELLERS & CO.:

GENTLEMEN,—In reply to your inquiry regarding our experience with your *Seven-Ton Hammer*, I take pleasure in making the following statement:

We have been running the Hammer almost constantly for about eighteen months, day and night, on steel. We produce thirty-five to forty tons of seven and a quarter inch blooms, from twelve-inch ingots, per twenty-four hours. Each ingot makes two blooms at one heat. The last bloom is, therefore, finished pretty cold, which brings very severe work on the Hammer.

Aside from the usual wear and tear, the Hammer has not broken nor cracked, nor shown any signs of distress.

My experience in working steel with heavy Hammers, in which the hammer head works in the frames, is that the frames are violently shocked and often broken by the *direct* lateral blows and strains of the head.

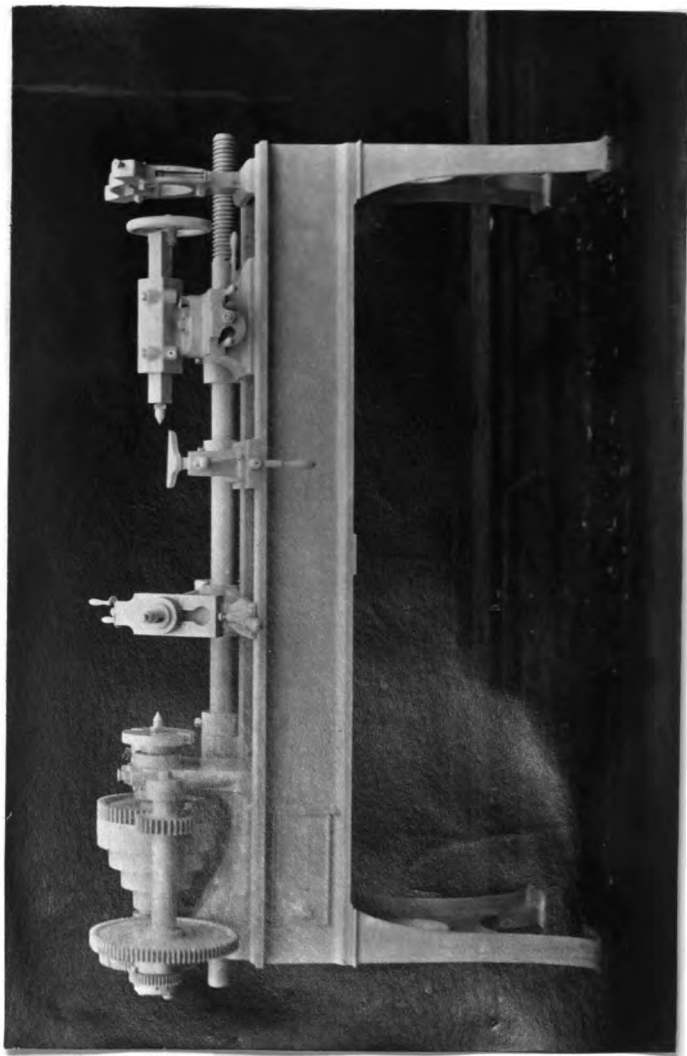
In your form, however, the lateral strains of the head are distributed over the whole arch of the frame, and are reduced in violence by the elasticity of the frame. The shape and proportions of the parts also appear to contribute to the distribution of strains, and to their *elastic* rather than to their direct and rigid resistance.

Yours truly,

A. L. HOLLEY,  
*Manager.*

One of the hammers spoken of by Messrs. Park, Brother & Co. was the first hammer made by us. The one alluded to by Mr. Holley was the second one. Both are at this time (1873) in excellent order.





## 20-INCH CHASING LATHE,

Arranged especially for brass work, live head back geared; hardened steel spindle running in hardened steel bearings; patent back thrust to spindle; iron cone pulleys turned inside so as to be perfectly balanced. Spindle for holding the chasing hobs so arranged as to accommodate two different pitches at the same time. Also to cut with single-pointed tool either single, double, triple, or quadruple threads. Slide rest for patent chasing arrangement carried by bar at back of lathe; counter-weight to chasing bar, pressing either to or from the face plate; poppet head with square spindle and detachable screw for quick motion, can be adjusted to any taper when used to carry turning tools, and is provided with slide rest movement; patent holdfast for poppet head; hand tool rest with convenient holdfast; steady rest; over-head shaft fitted with ball and socket hangers, and one fast and two loose pulleys, all 16 inches diameter, 5 inches face, which should run 168 revolutions per minute, with open and cross belts to run the lathe at uniform speed either way.

**T**HIS is a special tool, made in the first place for our own use in our Injector shop, and there demonstrated to be a better tool for general brass work than any yet made. It cuts screws by means of a hob of the requisite pitch on the spindle back of the lathe spindle. The back or poppet head has all the movements of an ordinary slide rest, and is made to carry either boring tools or turning tools, and permits of the most economical working of chucked work. Lathes of this kind are not used for turning work between centres, but for operating upon work held and carried by the face plate; thus, upon the bodies of all kinds of globe valves and brass work generally.

Hob for cutting screws.

Turning chucked work.

To use it to advantage on any special work, a system of chuck plates adapted to hold the work (if a universal chuck is not applicable) should be arranged by the purchaser to permit his placing the pieces to be turned in the readiest way upon the face plate.

## PATENT WHEEL TURNING LATHE,

To swing 6 feet 8 inches diameter; extreme distance between face plates, 8 feet 6 inches; for boring or turning both wheels at once, with two geared head stocks, two large face plates, with external and internal wheels driven independently, so that the workman may be chucking on one and turning on the other at the same time; with two compound slide rests, self-acting feeds in all directions, over-head shaft, ball and socket hangers, and iron cone pulleys turned inside so as to be perfectly balanced, and a full set of wrought iron wrenches. Wrought iron work case hardened.

Same tool with one geared head stock and one slide rest; in other respects as above.

Same tool with one geared head stock and two slide rests; in other respects as above.

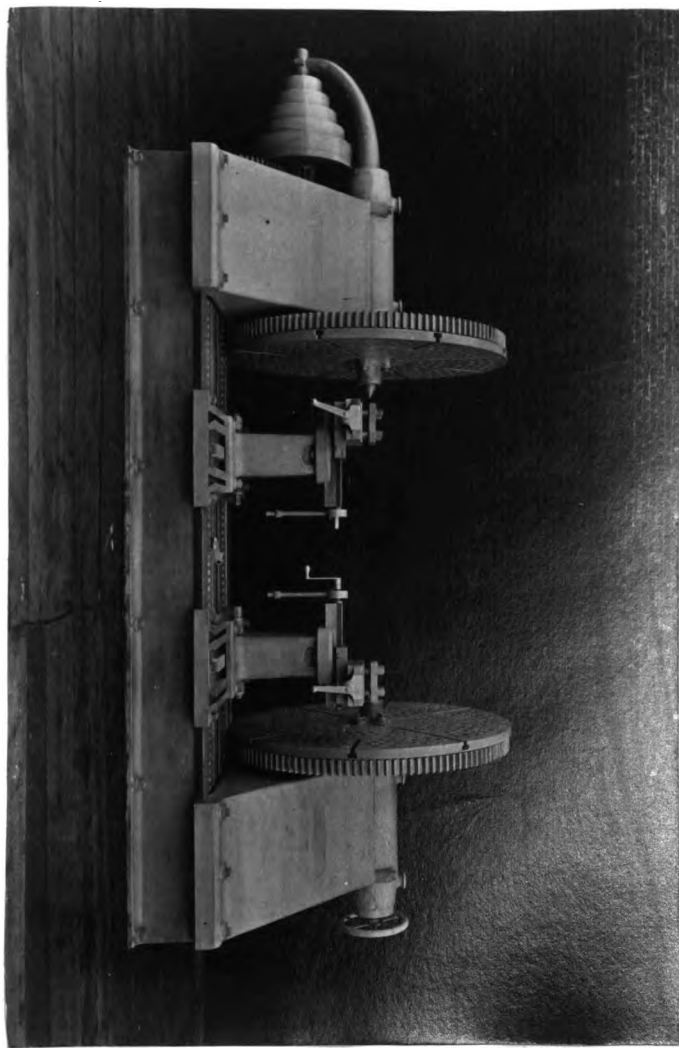
**T**HIS is believed to be the most efficient tool for turning driving wheels for locomotives that has been built. Its principle admits of unusual stability. The pressure of cut falls always within the bed surface, and its exceeding simplicity recommends it for the work it is designed to do. The feed is obtained from a rock shaft placed over-head, from arms on which, chains are carried to ratchet feeds on the compound slide rests. This enables the feeds to be operated to equal advantage in all directions by power, and to be entirely under the control of the workman. We recommend the machine with two driven face plates and two slide rests, but we make it when required, as is shown in specification, with one geared head stock only. The difference of cost, in our estimation, does not warrant the dispensing with the two face plates, the work being done so much more rapidly when both wheels are driven at once. By its use wheels may be taken from under an engine and the tires re-turned with but a few hours' detention of the engine in the shop. Fast and loose pulleys on the counter-shaft, 24 inches diameter, 7 inches face, 150 revolutions per minute.

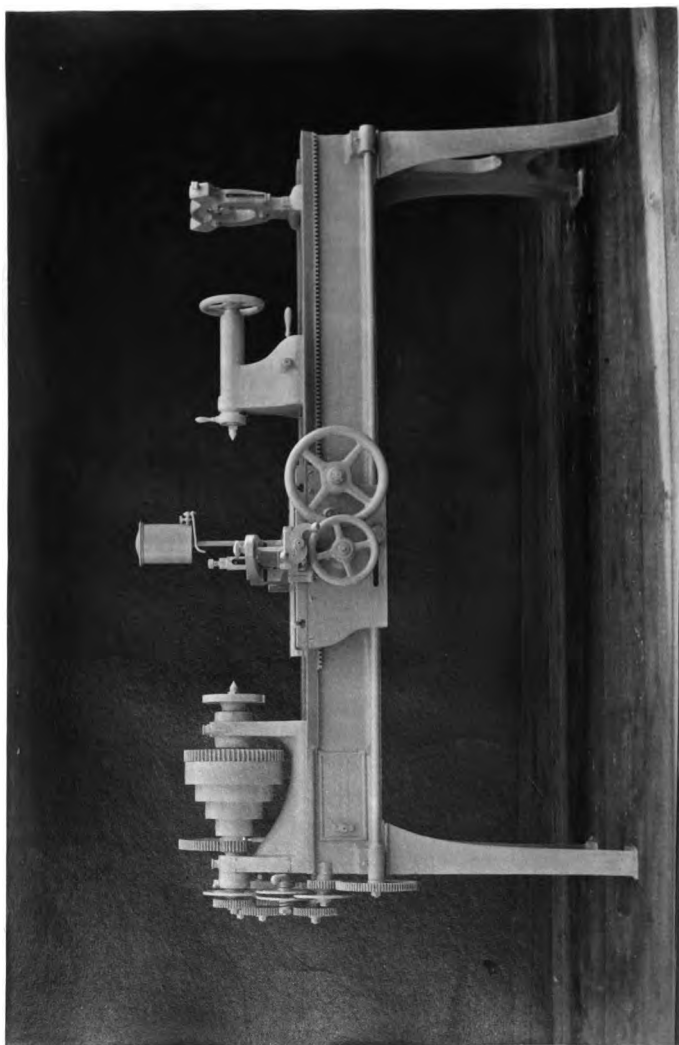
Pressure of cut  
within surface  
of bed.

Feed.

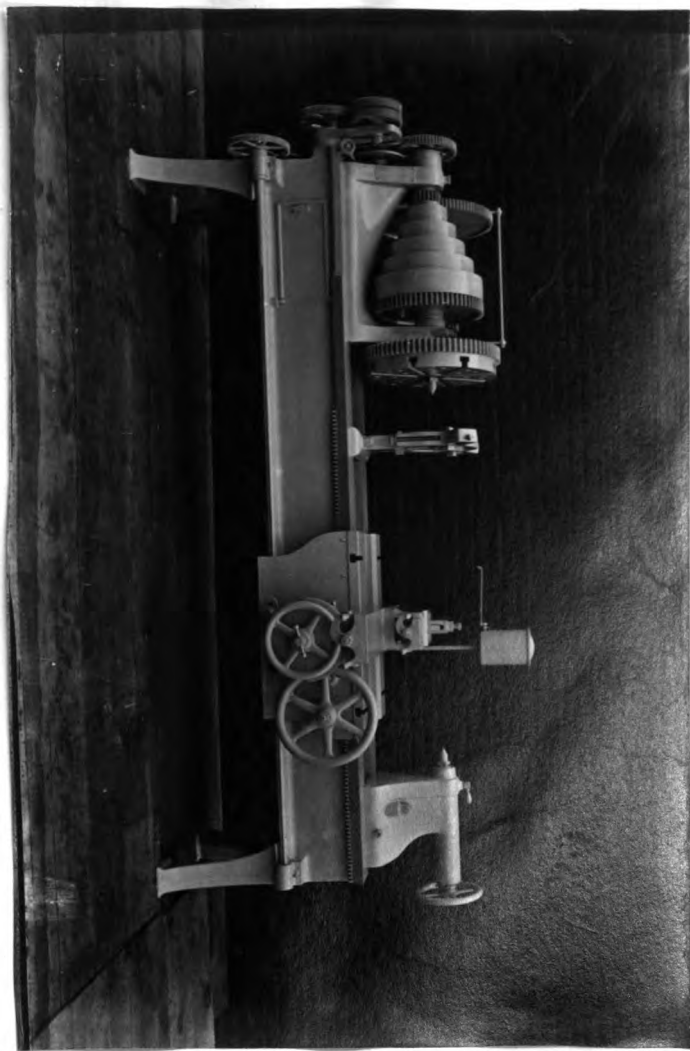
Two face  
plates.

Speed.

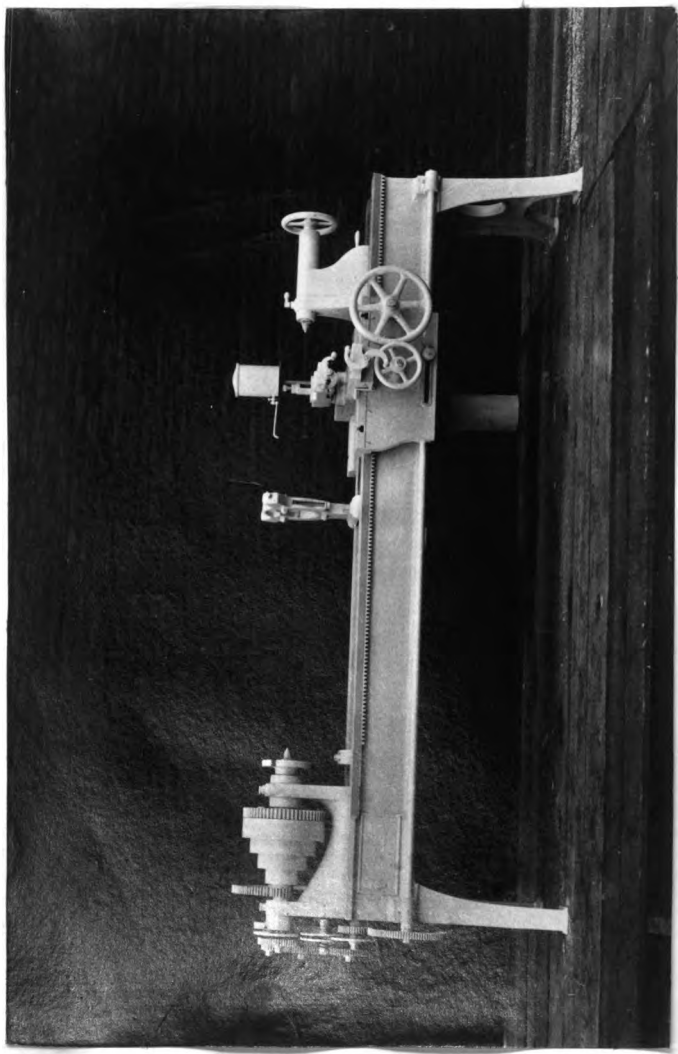








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## SELF-ACTING SLIDE LATHES.

### **For 48 Inches Swing and Under,**

With screw cutting and turning feeds so arranged as to be instantly changed from one to the other, when both are in gear with the spindle; turning feed adjustable to any speed between the fastest and the slowest; for lathes to swing 16 inches and under, the turning tool has a vertical adjustment on a single slide rest; for 20 inches and above, the slide rest is compound; and for 25 inches and above, this rest has a self-acting cross feed; quick hand traverse to bottom rest on all sizes; for 20 inches swing and under, the spindles are made of hardened cast steel, running in hardened cast steel bearings, and all other sizes up to 48 inches, inclusive, have steel spindles, running in best composition bearings. Beds flat on top, with improved hold down for poppet head, insuring the centre being in line with the axis of live spindle. Concentric hold fast to spindle of poppet head. Back stay.

### **Lathes Over 48 Inches Swing,**

With cast iron spindles, and the cone pulleys and back shaft drive through the face plate only, with fifteen changes of speed; self-acting screw feed, used for both screw cutting and turning, and self-acting cross feed; bed with three flat surfaces for saddle, so arranged as to receive pressure of cut within the bed surface; rack movement for shifting poppet head.

Feed screw on all sizes supported the entire length. Beds of any required length. Over-head shaft with ball and socket hangers and iron cone pulleys turned inside, so as to be perfectly balanced; wrought iron wrenches. Wrought iron work case hardened.

## LATHES, SELF-ACTING SLIDE.

Name of lathe: that is, diam. of piece will swing clear of bed.	Diam. will swing over rest.	Distance from centre to cen- tre of girts.	No. of girts beyond live head.	Distance be- tween cen- tres.	Total length of bed.
12''	10''	10''	4	2' 5 $\frac{1}{4}$ ''	4' 4 $\frac{1}{2}$ ''
16''	13 $\frac{1}{2}$ ''	13''	4	3' 2''	5' 8 $\frac{5}{8}$ ''
20''	17 $\frac{1}{4}$ ''	16 $\frac{1}{4}$ ''	4	4' 0 $\frac{1}{2}$ ''	7' 1''
25''	21 $\frac{1}{8}$ ''	20 $\frac{1}{4}$ ''	4	5' 1''	9' 0 $\frac{1}{4}$ ''
30''	26 $\frac{1}{8}$ ''	24 $\frac{1}{8}$ ''	4	6' 0 $\frac{5}{8}$ ''	10' 9''
36''	31 $\frac{1}{8}$ ''	29''	4	7' 4 $\frac{1}{2}$ ''	12' 10 $\frac{5}{8}$ ''
42''	37 $\frac{1}{2}$ ''	33 $\frac{3}{4}$ ''	4	8' 7 $\frac{1}{2}$ ''	14' 11''
48''	42 $\frac{5}{8}$ ''	38 $\frac{1}{2}$ ''	4	9' 10 $\frac{1}{2}$ ''	17' 0 $\frac{3}{4}$ ''
60''	49''	28''	6	8' 10 $\frac{1}{4}$ ''	17' 2 $\frac{1}{8}$ ''
72''	57 $\frac{1}{2}$ ''	31 $\frac{1}{8}$ ''	8	15' $\frac{1}{4}$ ''	25' $\frac{3}{4}$ ''

PROMINENT in the list of tools for the equipment of the workshop stands the lathe. It was the first machine tool; it is the most important. Upon it has been expended much thought, and about it much has been written. During the past few years the lathe has been much improved; its functions have been carefully studied, and its form changed to agree with the now better-known theory of its operation. Traditional shapes and devices have been discarded, and new ones are becoming familiar to the men who work at it.

Requirements.

It must be conceded that the requirements of a

good turning lathe are that it must turn a true circle, it must turn a true cylinder, and it must, when facing off, produce a true plane surface. The screw-cutting lathe must, in addition to these requirements, produce a sufficiently perfect thread. It is not only necessary that the lathe should fulfill these requirements when new, but it should continue to fulfill them year after year, with the least possible need of adjustment and repair. It has been said that good workmen can do good work with poor tools. Skill and ingenuity may indeed accomplish great results; but the problem of the day is not only how to secure more good workmen, but how to enable such workmen as are at our command to do good work, and how to enable the many really skillful mechanics to accomplish more and better work than heretofore; in other words, the attention of engineers is constantly directed to so perfect machine tools as to utilize unskilled labor.

*Requirements.*

*Lathe must do good work with less skill.*

The turning lathe, being the oldest of all machine tools, has been more hampered by traditional devices and shapes than more recently-contrived machines. Changes for the better have to be made, often in opposition to prejudices of the workingmen. This opposition has not, however, deterred us from steadily improving this machine, as new uses and new requirements seem to demand a change. Much more is required of the turning lathe now than was thought of but a few years ago; more and better work must be done by it with less skillful workmen, and it must be adapted to the various kinds of work required of it in particular kinds of manufactures. Thus many lathes, adapted to special purposes, have been designed and designated by the names of the classes of work they are intended to accomplish.

*Prejudice of workmen.*

*Lathes for special work.*

In reference to the bed or shear, we uniformly make what is known as the flat-top shear, not the V shear. This latter has been the favorite in this country for many years ; the flat-top shear is the rule, not the exception, in England. In view of the well-known fact that durability of machinery is largely dependent upon extended surface, where surfaces move or slide one on another, it is rather surprising that the flat-top shear should have met with so little favor in this country up to quite a recent period. Theoretically, it presents the largest wearing surface, and is the most easily made. The saddle of the slide rest, bearing over its whole under surface, may find a support up to the edges of the centre opening of the shear. Having less distance to span unsupported than on the V shear, the saddle can be made thinner and yet strong enough, thus increasing the capacity of the lathe swing over the slide rest. On lathes with V guides there are usually four of these guides, the two outer ones serving as guides for the saddle, and the saddle must, of necessity, span the entire space unsupported from one V to the other ; hence it must be thicker and heavier than if resting on a plane surface. The nominal capacity of any lathe is what it will swing over the shear. The actual capacity in relation to cylindrical work is what it will swing over the slide rest ; hence the advantage of less thickness in the saddle, if of sufficient strength.

Flat-top shear.

Saddle made thinner.

Nominal capacity of a lathe.

Those workmen who have not used lathes with flat-top shears are apt to think that the extended surface in contact with the shear may make it hard to move. If it be allowed to stick fast with gummy oil, this may be so ; but with such care as any machine-tool should receive at the hand of the workmen,

it is really easier to move. Friction being dependent upon weight, not surface, the flat-top shear, owing to the extended bearing surface, will permit the use of much lighter saddle, and the dust and dirt are no more apt to catch upon the flat shear surface than on the V shear, and are as effectually pushed off by the saddle. Lightness in the slide rest becomes of great moment on lathes of large capacity, and is worth considering in all lathes.

The flat-top shear can be readily planed true on its upper face, on its outer edges and on its inner edges. The outer edges guide the saddle, lost motions being taken up by shoes or gibs. The lathe heads are guided by the inner edges. The parallelism of all these edges can be readily insured. Convenience in moving requires that the poppet or back head, which (with the flat-top shear) is guided by the inner edges of the shear top, should slide easily, and hence should fit loosely. It is of the utmost importance that it shall always hold the same position as to line with the other parts of the lathe when clamped. This suggests the placing of a V on the under side of one of the inner edges, and thus, by mean of the clamping shoe, draw the head always up to the same straight-edge. We consider this combination of a clamping V on the under side of the shear top with the flat surface above it as one of the most important modern improvements on the lathe.

The function to be performed by the lathe shears or bed is to maintain the driving head or live head spindle in line with the poppet head spindle, and to carry the cutting tool parallel with this centre line. It must do this under various conditions of strain. Screwing up the centre to hold the work, tends to

Friction depends on weight.

Facility of construction.

Guide for back head.

V on under side of flat top.

Function of the shears.

Twisting of  
shear under  
cut.

bend the shear in one direction. The strain of the cut tends to bend it in another, in fact, in several directions.

Cross girts.

Lead screw  
in trough.

Spindle.

It must be borne in mind that the lathe centres, being above the shear, and dependent entirely on the stiffness of the shear for their rigidity, are placed at some disadvantage in regard to leverage. A clear idea can be obtained of resultant strains if thought be directed to a lathe with a rigidly fixed live head and a very flexible shear. The work, being also rigid, will be driven around its axis by the rotation of the live head spindle, and will therefore tend to turn the slide rest, the shear and the poppet head around the axis of rotation, thus producing a severe torsional strain on the bed. Hence the bed must resist strain in all directions; the longer the bed the more elastic it would be in regard to torsion, an evil to be corrected only by the system adopted by us of introducing cross girts on all our lathe beds. These cross girts, from the peculiar construction of our lathes, extend near to the top of shear, and form inflexible ties between the two I beams, which represent the sides of the sheaf. The lead screw in screw-cutting lathes is placed within the bed, and, supported over its entire length by resting on a trough planed out to receive it, it is not subject to deflection; maintaining its right line will produce a truer thread, than if unsupported, except by the nut and end-bearings. By being placed under the shear top, it is entirely protected from falling chips and dirt.

Upon the perfection of workmanship on the spindle of the live head depends the possibility of turning a true circle; upon its freedom from end motions and the exact placement at right angles to it of the line



of cross slide of the slide rest, depends the possibility of producing a true plane in facing.

The spindle must be round—truly round—as it will reproduce its own shape in the work being turned. Theoretically, a hardened steel spindle, running in hardened steel bearings, the spindle and bearings being made true after having been hardened, presents the most reliable conditions of correctness and durability. Fortunately, the modern improvements in methods of working hardened steel furnish means of perfecting this important part of the turning lathe; but to adapt it to the possibility of economical construction, more important changes must be made in form. The customary collars at each end of the journal are dispensed with, and the front journal of the spindle made truly cylindrical and supported over its entire length by a truly cylindrical bearing. The back bearing is conical, and one stationary ring or collar of hardened steel secured to the spindle back of the back bearing, is ground true, and is made to run between hardened steel plates without any lost motion whatever, and no liability to stick or jam. This form of back thrust does away entirely with the tail screw, presents a more extended and durable wearing surface, and permits the spindle to be extended through the back support, and thus receive change wheels of any size for screw cutting or feed. The form of the live head stock is such as to hold the front bearing in a rigid manner against lateral strains, and the back bearing against a strain of the spindle pressed endways.

The cone pulleys are so proportioned to the gearing on back-geared and triple-geared lathes as to insure an exact ratio of change from the fastest to the slowest speed in each and every change,—that is, with five

15 speeds.

lifts to the cone in a triple-gear lathe, 15 speeds should be possible, each proportionately slower than the one next to it. The cone pulley or spindle is turned inside and out, so as to be perfectly balanced, and, in its inner sleeve, presents an extended bearing upon the spindle capable of proper lubrication. The spindle of lathes of 20 inches swing and under is of the best cast steel, and, being first roughed out, is hardened and then reduced to proper shape and size by suitable machinery. The taper hole for the live centre is finished true after the spindle is made true on the outside. The truth of this hole is just as important as the accuracy of the outside of the spindle. Upon its absolute concentricity with the outside of spindle depends the possibility of the centre point running true, no matter how replaced after it has been taken out.

Taper hole for  
centre.

Too much care cannot be taken with the manufacture of this important part of the machine. Hardened steel spindles have been made in this manner for lathes as large as 48 inches swing, the front journal of such a lathe being 5 inches in diameter; but the practical difficulties in the way of working with safety such large masses of hardened steel prevent its adoption for spindles over about three inches in diameter.

Face plates.

On all double-gear lathe we make the face plates to unscrew for convenience of changing to various sizes and the ready application of chucking devices. The overhanging end of the lathe spindle to receive the face plate has a portion of its length next to the shoulder, cylindrical without any screw thread. The screw on the end is short and fits loosely in the face plate; but a careful fit is made in the face plate of the part carried by the plane part of the spindle, and the

shoulder against which the nut of the face plate abuts is made very true. This arrangement insures the face plates always running true, no matter how frequently they are changed nor how loosely the screw may fit, provided they are not bruised or injured in the fitting parts.

Face plates.

Spindles made as described have been tested during many years' constant hard usage, and have been found to show no appreciable wear. Possible adjustment of all wearing parts should be provided, but such adjustment should not be at the convenience or whim of the workman using the machine, as is the case with the spindle collared at its journals and provided with a tail screw for the back thrust.

Durability of hard spindles.

We have already mentioned the method of holding the poppet head so as to insure its alignment by means of the V on the under side of the flat-top shear. Its spindle is carefully fitted, and is clamped at its extreme end of bearing, next to the work, by means of a split conical sleeve forced in by a screw, which takes up all lost motions or play and insures its central position. If lathes were not required to turn tapers as well as cylinders, there can be no doubt that the poppet head, made in one piece, resting on the shears over a sufficiently broad surface and capable of adjustment sideways only to the extent of practical alignment, would be the simplest and the best. In our own practice we prefer this system, and adapt to lathes requiring it a device which enables the turning tool to be guided by former bars, and thus to produce tapers or irregular shapes, such as the curves of handles, etc. This device, called technically "a former attachment," does much better conical or tapered work than with the centre set over out of line, for reasons obvious to

Hold fast for poppet head.

Turning tapers.

Former attachment.

How to line  
centre.

all mechanics familiar with the use of the machine, and gives a greater range to its capacity. We may be pardoned for mentioning in this relation what we consider the readiest method of bringing the centre in line after the head has been set over, in adjusting the centres in the first place or in testing the correctness of a new lathe. A bar of round iron carefully centered, is turned up a short distance on one end. This turned end being placed next to the live head centre, a turning tool clamped in the slide rest is made to just touch the turned part. Taking out the bar, the tool is then moved over to the poppet head spindle, and the bar reversed with its turned end next to poppet head centre, when, if the tool just touches the turned part as before, the lathe may be considered in adjustment.

Feed discs.

Stopping and  
starting  
motions.

In lathes in which the turning feed is independent of the screw cutting feed, we use our patent feed discs, which permit a gradation to suit the nature of the work between the extremes of speed. When (as is the case in large lathes) there is an automatic cross feed provided, the various feeds are so arranged as to be readily changed from one to the other. Having set in gear any one of the feeds, it can be stopped and started by one and the same motion for all the feeds. Such motions as screwing up the spindle of the poppet head, stopping and starting feeds, setting up the slide rests, etc., are motions of habit, and should, if possible, be uniform on all lathes. This is especially the case where two kinds of feed are operated by the same starting gear. No complication of motions should embarrass the workman. There should be no hesitation on the part of the workman as to which way he should move the starting gear in any case. The cross slide of the slide rest, in fact, all the slides of the rest,

Slide rest.

are so made as to entirely cover their sliding surface, Slide rest. and thus exclude all dirt. This is of the utmost importance, and too often neglected by makers of otherwise very good lathes.

For lathes up to 36 inches swing the very convenient single screw tool post can be used to advantage; but Tool post. for larger lathes it is not possible to hold the tool in this manner alone, if the lathe is proportionally powerful. Four screws or standing belts with clamp plates serve a better purpose and admit of a greater range of tool positions.

It is claimed by some that cheaper, lighter lathes will answer a good enough purpose. It has been clearly demonstrated that with a good lathe, made abundantly strong enough for the heaviest work, more and better work of a light character can be done than in lighter build of lathes. This is due, in the first place, to perfection of workmanship in the tool, and secondly, to its freedom from vibration and absence of deleterious lost motion. Can do light work in a heavy lathe.

A very marked saving of time is manifest in the use of these machines, from there being no adjustments required in the working parts by the workman. Work chucked in the face plate, or held between centres, is operated upon without any change in the back thrust of the live spindle. In reference to the table accompanying the specification, it will be seen that for each size the distance between centres and total length of bed corresponding is given for the shortest length of lathe bed made. In column headed "Distance from centre to centre of girts" is found the amount that the bed may be lengthened by the addition of similarly spaced cross girts. To understand this properly, it must be borne No end play in spindle. Estimating length to turn.

Spacing of the cross girts.	in mind that the shears or bed can be cast of any desired length, but the spacing of the cores which make the inside of shears makes it necessary to gauge the length not only by feet and inches, but by addition of girt lengths. Thus: an inquiry is made for a lathe to swing 25 inches over the shear and to turn 10 feet between the centres. Reference to the list shows that the shortest length of 25-inch lathe takes in 5 feet 1 inch; this is 4 feet 11 inches too short; distance from centre to centre of girts is $20\frac{1}{4}$ inches, 3 additional girts $20\frac{1}{4} \times 3 = 60\frac{3}{4}$ inches, = 5 feet $\frac{3}{4}$ inch, added to 5 feet 1 inch = 10 feet $1\frac{3}{4}$ inches, which will answer for the case, and is the nearest that it can be made to the required size; but should the lathe be required to take in 10 feet 6 inches, an additional girt will be needed, making 4 extra girts, and such a lathe will take in 11 feet 10 inches; this is more than is called for, but is the nearest to the required size our pattern will admit of.
Example of length.	
48-inch lathe.	All our lathes, up to 48 inches swing inclusive, are made on one general principle, so far as form is concerned. There is a similarity in most essential parts, but a difference in detail. 12-inch and 16-inch lathes have a vertical adjustment to the point of the tool (this is more needed in turning small diameters than in large diameters). 20-inch lathe has compound slide rest, but has no cross feed by power. Over 20 and up to 48 inches, inclusive, there are automatic cross feed and longitudinal feed; so also in the still larger sizes; but up to 48 inches the feeds for turning are independent of the screw cutting feed, while for sizes over 48 inches there is but one feed for screw cutting and turning. We are enabled to produce a lathe for diameter over 48 inches in this manner at
16-inch lathe.	
20-inch lathe.	

less cost, and answering in many respects a better purpose, than upon the plan of the smaller sizes. These large lathes are admirably adapted to doing very heavy work, such, for example, as turning rolls for rolling-mills, in which case the cuts required are very heavy, and at the same time have a greater capacity over the slide rest than is attainable by other methods. These large lathes have, in all cases, three flat bearing surfaces on the bed for the saddle to rest on. We make all the counter-shafts of our screw-cutting and turning lathes with one fast and two loose pulleys, so as to permit the use of open and crossed belts in cutting screws, and the driving pulleys on line should be arranged to run the lathe backwards at double the forward speed. The proper speed is given in the following tables, which show the arrangement of counter-shaft pulleys both for screw-cutting and turning lathes, and for turning lathes only.

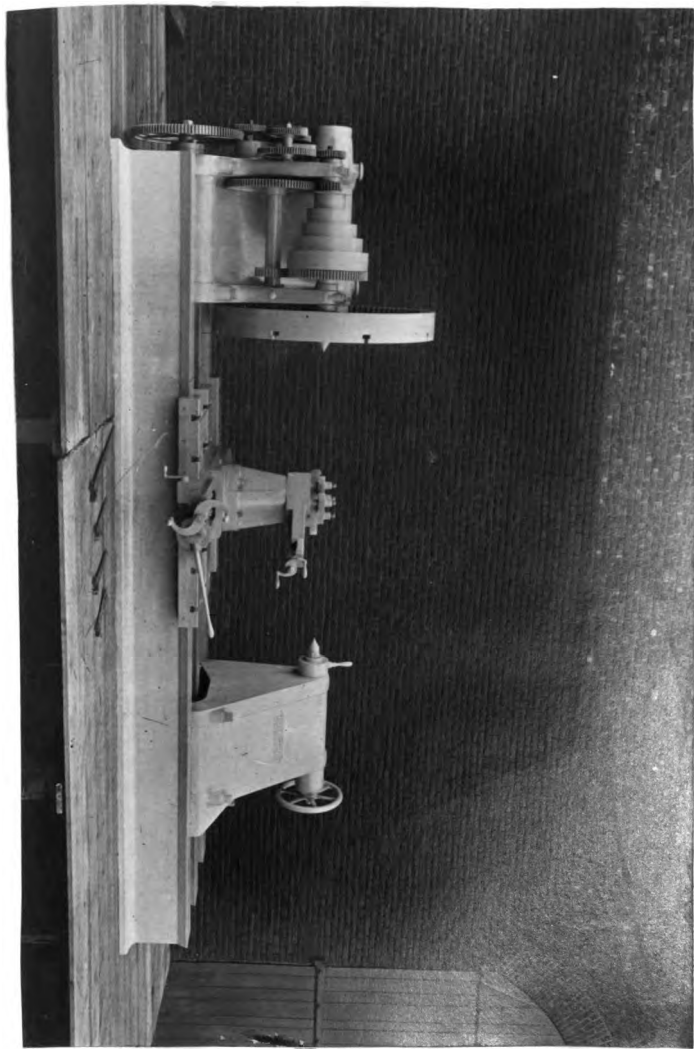
TURNING AND SCREW-CUTTING LATHES.

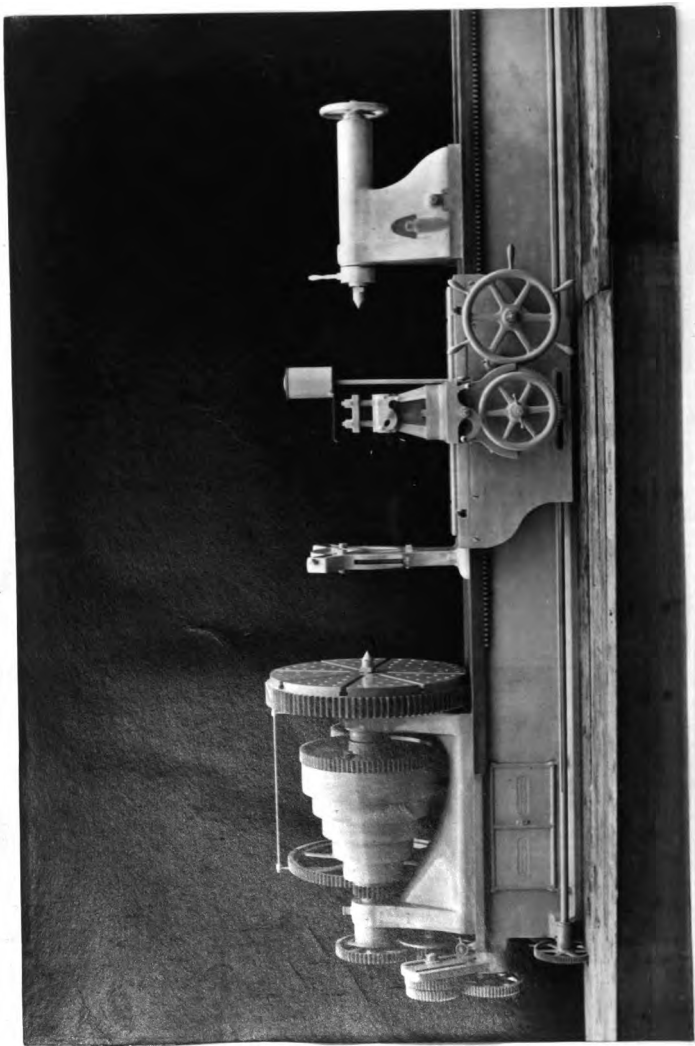
Size of Machine.	Speed Under-cut.	Speed Running Back.	Fast and Loose Pulleys.			
			Diameter.	Face.		
				Loose.	Fast.	Loose.
12 inch.	200 Rev's.	360 Rev's.	6-inch.	4''	4''	4''
16 "	150 "	300 "	9 "	4''	4''	4''
20 "	112 "	224 "	10 "	5''	5''	5''
25 "	135 "	270 "	14 "	7''	7''	7''
30 "	110 "	220 "	16 "	7''	7''	7''
36 "	98 "	185 "	20 "	4''	7''	4''
48 "	90 "	180 "	26 "	6''	12''	6''
60 "	140 "	280 "	16 "	7''	7''	7''
72 "	122 "	244 "	20 "	8''	8''	8''

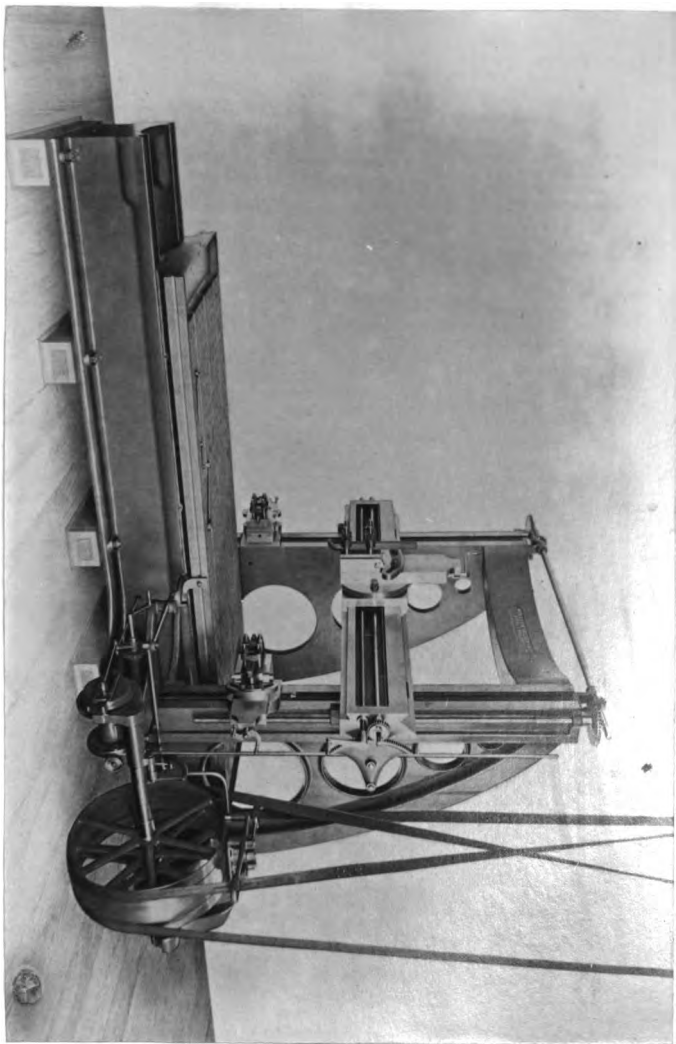
## TURNING LATHE.

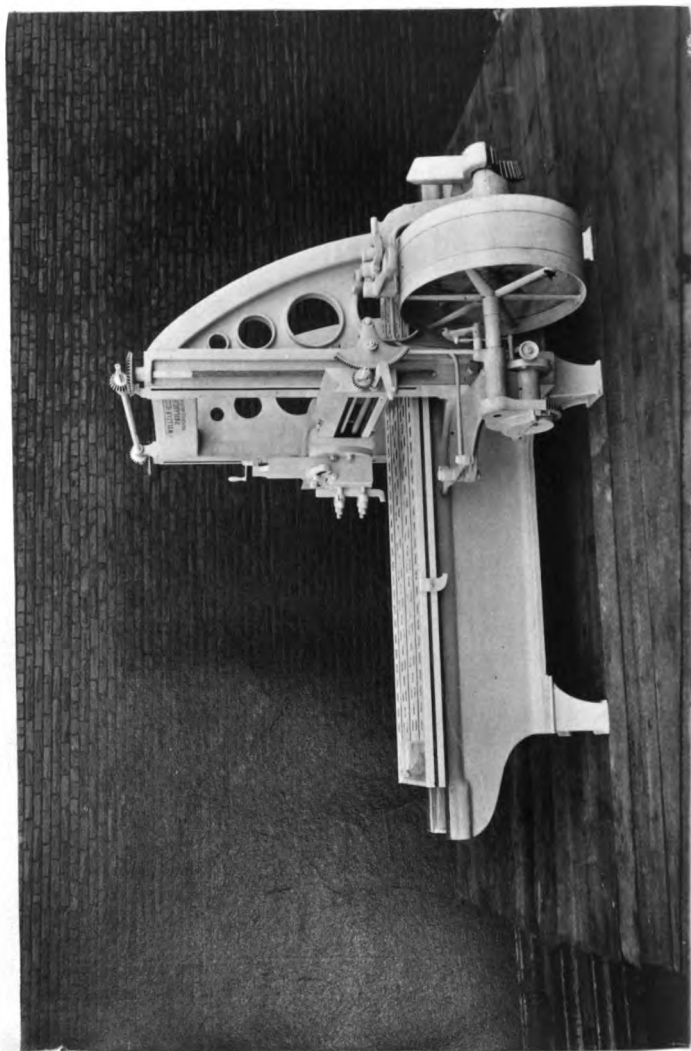
Size of Machine.	Speed Under-cut.	Fast and Loose Pulleys.		
		Diameter.	Face.	
			Fast.	Loose.
12 inch.	200 Rev's.	5''	2½''	2½''
16 "	150 "	8''	2½''	2½''
20 "	112 "	10''	3''	3''
25 "	135 "	12''	3½''	3½''
30 "	110 "	14''	4''	4''
36 "	98 "	18''	4''	4''
48 "	90 "	26''	6''	6''











## PATENT SELF-ACTING PLANING MACHINE.

**For horizontal, vertical, and angular planing of any required length, with spiral gear driving motion; positive geared feeds, self-acting in all directions, with tool lifter operating at all angles, and improved belt shifter.**

This machine stands parallel with the over-head driving shaft, thus economizing room in the shop; the bed and table are fitted to uniform gauges so that the table will work with either end toward the uprights, or on any bed of the same size machine, thus insuring the correctness of the ways.

The over-head shaft is fitted with ball and socket hangers, and the pulleys are perfectly balanced; a full set of wrought iron wrenches accompanies each machine, and wrought iron work is case hardened.

Name of Planer.	Will plane in width.	In height.	Shortest length of table.
20 inches.	20 inches.	20 inches.	3 feet.
25 "	25 "	25 "	3 feet 7 inches.
30 "	30 "	30 "	4 " 2 "
36 "	36 "	36 "	4 " 8 "
42 "	42 "	42 "	5 " 4 "
48 "	48 "	48 "	6 "
54 "	54 "	54 "	6 " 7 "
60 "	60 "	60 "	7 " 3 "
72 "	72 "	72 "	8 " 6 "
84 "	84 "	84 "	10 "

These machines can be of any required length.

**T**HIS machine, differing in so many particulars from planers as heretofore made, has proved itself so durable and efficient as to have attracted the attention of all the principal users of such machines. The editor of the *Practical Mechanics' Journal*, London, in commenting on the machine tools exhibited in the Paris Exposition of 1867, begins an article on "American Planing Machinery":

"Amidst the countless machine tools exhibited last year in Paris by every foremost maker in every prominent nation in the world, there were none so remark-

able for the breezy freshness and originality in the conception and carrying out the contrivance of various parts, by which the combined action of each machine tool as a whole was obtained, as those produced in the United States divisions by Messrs. William Sellers & Co., of Philadelphia." We here reprint the substance of the description of these machines, as given in that journal, adding such remarks of our own as may assist in a full appreciation of the merits claimed for this tool :

Driving the  
planer.

Machine stand  
parallel with  
lathes.

Action of the  
spiral pinion.

"Most conspicuous and important among the various novel features of this machine is the manner of giving motion to the table ; this is furnished with a rack, but instead of being operated by the ordinary spur gearing, it receives motion through a peculiar form of spiral pinion upon a driving shaft which crosses the bed diagonally, and passes out in the rear of the upright, on the side where the workman stands. This shaft is driven from the pulley shaft by means of a bevel wheel and pinion. The position of the pulley shaft places the driving belts within convenient reach of the operator ; and its axis being parallel with the line of motion of the table, these machines may be placed parallel to lathes, and thus economize space and permit a better arrangement of workshops. By this simple driving arrangement a very smooth and uniform motion is imparted to the table ; the pinion has four teeth, and is, in fact, a short piece of a coarse screw, the position of the teeth upon the same being as the threads of a screw of a steep pitch, and of a like number of threads to that of the teeth in the pinion. This pinion being placed upon the diagonal driving shaft, its action differs from that of an ordinary spur wheel, as it also does from that of a worm ; that is to say, if

the driving shaft were at right angles to the rack, the pinion would be the ordinary spur ; but if it were inclined to the rack, say  $5^{\circ}$ , the teeth of the pinion would require to be slightly curved, and would commence driving at one side of the rack, shifting gradually to the other as it revolved. The same process takes place at any other angle, the sliding cross motion being more rapid the greater the angle from the perpendicular, until it reaches  $90^{\circ}$ , when it becomes a worm, and the teeth of the rack would then require to correspond with the angle of the thread. With the present arrangement, however, the teeth of the rack must be straight, but may be placed at any convenient angle to the line of the rack. Although the teeth of the latter are straight, and those of the pinion curved, the surface of contact and wear upon the rack is not limited to a small central portion of its teeth, but uniformly distributed over the whole width of the rack.

Teeth of rack  
straight.

"In the arrangement we are describing, the teeth of the rack are placed at an angle of  $5^{\circ}$  to its line of motion, to counterbalance any tendency the pinion might have to move the table sideways. The driving shaft revolves in bearings at both ends of the spiral pinion ; these bearings are cast in the bed and connected by a trough surrounding the pinion, which trough is covered by caps under the rack, thus preventing chips and dust from reaching the pinion ; the oil placed upon these bearings can escape only into this trough, and furnishes sufficient lubricating material for the pinion and rack.

Pinion protected from  
dirt.

"It is a mistake to suppose this pinion must run in oil ; in fact, such a condition of affairs would be highly injurious, as the oil would be thrown off by the revo-

Oiling the  
pinion.

Thrust of  
pinion shaft.

lution of the pinion, and would become a serious nuisance. The thrust upon the driving shaft from the motion of the table under-cut, is received against a step-bearing in front, and the lesser thrust during the quick return motion is received against hardened collars at the other side of the spiral pinion.

Bracing in  
bed.

"It will be noted that the sides of the bed directly between the uprights are very firmly braced by a box-shaped connection, the diagonal driving shaft not interfering with it, thus strengthening the most vital part of the machine, as is the case in most of the ordinary forms of planers; the same space being in some rack planers occupied by the gearing, while in the screw planer the height of the cross braces must be much diminished to give room for the screw and nut.

Position of  
belts as re-  
gards work-  
man.

"The disposition of the driving shaft and gearing in this machine may also be looked upon as an improvement over the frequently adopted plan of placing the driving gear and pulleys in front of the uprights, on the side of the machine opposite to the attendant; in which position these parts and the belts are apt to interfere with the planing of pieces overhanging on that side of the table, and are out of the reach of the operator. The transmission of motion to the table from a high speed of belt is accomplished by a single pair of bevels, the largest one of which may be easily made of such diameter, relative to the pinion, as to give the required reduction of speed and transmission of power without the intervention of other gearing. This arrangement has evident advantages over the ordinary screw planer, in which the gearing at the end of the screw is limited in size by the table projecting over the ends of the bed. The device for shifting the belts in the Sellers' planer is another

Bevel wheel.

Belt shifter.



peculiarity worthy of notice ; it consists of a curiously shaped lever, vibrating horizontally upon a fulcrum pin placed between the fulcrums of the two belt shifters ; the whole being supported upon an upward extension from the cap of the rear bearing of the pulley shaft. The middle arm is provided on opposite sides with an internal and external projection or tooth, these teeth meshing with corresponding notches and projections on the respective shifters ; the teeth upon the middle lever are relatively so disposed that the motion of one shifter is effected and completed before that of the other is commenced, which arrangement combines, with the least possible lateral motion of the belt in shifting, the important advantage of entirely removing the one belt from the driving pulley before the other commences to take hold to reverse its motion. The shifting is thus effected with very little power, and the shrieking and undue straining of belts avoided.

“ The variation of stroke of the table is obtained by means of the usual adjustable stops on the side of the table, which stops actuate the above-described shifting device by means of a double-armed lever and link connection. This lever and link are in the most convenient position for changing the position of the belts independent of the stops, so that the workman can with great facility control and reverse the motion of the table by hand in setting the tool or in planing over intervening irregular lengths ; he can also set both belts on the loose pulleys, and thus at any point arrest the motion of the table without stopping the counter-shaft.

“ Several novel features are also introduced in the feed motion for the cutting tool, and in the devices

**Feed.**

for elevating the cutting tool during the return stroke of the table. The usual screw and central feed shaft are provided in the cross head for transmitting either a horizontal or vertical feed motion to the planing tool in either direction; they receive a variable amount of motion for any required amount of feed through a ratchet wheel, fitted interchangeably to their squared end projections at the front end of the cross head, where the ratchet wheel is actuated by a toothed segment, which receives at each end of the stroke the required alternate movements in opposite directions from a crank disc below by means of a light vertical feed rod. The crank pin on the feed disc below is so arranged that its throw and amount of feed can be conveniently varied and adjusted during the cutting stroke of the table, while the machine is in motion. By means of an ingeniously contrived double pawl and ratchet wheel, deriving motion from a pinion on the front end of the pulley shaft, the crank plate is at each reversion of the stroke alternately moved a half revolution, and disengaged in either direction; friction is only employed to throw the pawl into gear at each change of motion, whereupon a positive motion of the crank disc is kept up by the ratchet wheel until the pawl is disengaged from the teeth of the ratchet wheel by a positive stop. In nearly all planing machines the feeding motion of the cutting tool is obtained from the belt-shifter, which is actuated by stops upon the table, as described; such an arrangement entails an undue amount of work upon these stops, whilst the variations of feed obtainable in this way are quite limited; besides which, under many circumstances, it will be found necessary to make the feed under the cut, as the feed motion will be always actuated at the end of the

**Comparison  
with other  
methods.**

stroke before the motion of the table is reversed, whilst in a feed motion actuated from the gearing the motion **Feed.** will always be produced at the beginning of the stroke, and the amount of feed to be obtained in this way is practically unlimited. In nearly all modern planing machines the cutting tool is hung in what is called an apron, so adjusted as to allow the tool to swing loose **Apron.** on the back stroke of the planer table, but to be held rigidly when cutting. In large planers when the weight of the tool is great, and in all fine planing, this liberation of the tool is not sufficient of itself, but various arrangements have been added, whereby the tool **Lifting tool point on back motion.** point can be actually lifted clear of the work on the back stroke, and dropped into place ready for the cut after the article to be planed has passed under it; but perhaps none of these contrivances are so completely applicable as this one for lifting the tool in every position of the slide rest, and to do so from within the cross head, without interfering with any of the machinery for working the feeds, which occupy the centre, about which the adjustable part of the saddle rotates."

To this may be added that recent experiments seem to demonstrate that the great durability of the spiral **Durability.** pinions and rack used in driving these machines, is due to the fact that the action of the teeth is more a rolling action than a rubbing or sliding one. The ways or V's in the bed are provided with oil dishes at **Oil dishes.** end to retain the oil used in lubricating them, and the planer tables have self-operating oil scrapers, which, during the motion of the table, distribute oil uniformly over the surface of the ways. Planers up to 36 inches capacity, inclusive, are arranged with legs or feet to **Legs.** rest on the floor, but all larger sizes are intended to be

placed on foundations; and it is recommended that they be set upon stone sills crossing the bed at each pair of foundation bolt holes, so as to prop up the machine to the required height, and to permit the ready removal of the chips that may fall inside of the bed.

Length of  
table.

We name in our schedule of prices the shortest length it is possible to make these machines, and then give the price per foot for extension of table; and in the tabular lengths given the distance is measured from the centre of the cross dishes at each end of table, and not of the actual length of plane surface of table. We do this because, be the length of table what it may, if the work bolted to the table is stiff enough to overhang these dishes, it can be effectively operated on by the machine.

Erecting the  
machine.

Vertical slide  
rests on up-  
rights.

In placing these machines, it is of the utmost importance that they be carefully lined up when being put in place. On the larger sizes of planers we arrange vertical slide rests, attached to the uprights and operated by independent feeds, to enable work to be planed on the sides or edges at the same time that the surface is being planed. These are either adapted to one upright, or both, as may be required; and in case of one only being used, we place it on the working side of the machine,—*i.e.* on the upright next to the driving pulleys. These vertical slide rests are capable of being lowered below the surface of the table, so as to be entirely out of the way when not required. On locomotive work especially, these vertical slide rests are of great use. Two saddles are sometimes required on the cross head of planers of 36 inches capacity and over, to enable two cuts to be taken at the same time on the surface of work; they are so used in locomotive shops for planing frames and guide bars. When two saddles

Two saddles  
on cross head.

are adapted to any machine they are provided with a convenient method of moving them sideways, by hand, independent of the regular feed motions. Some care must be taken in placing the counter-shaft so as to insure the belts passing through the belt forks in the best position; to facilitate this setting, we send with each machine the following table:

Placing the counter-shaft.

DIRECTIONS FOR LOCATING THE COUNTER-SHAFTS OF WM. SELLERS & CO.'S PLANING MACHINES.

SMALL pulley on counter-shaft drives planer FORWARD, with a CROSS BELT.

LARGE pulley drives BACKWARD, with an OPEN BELT.

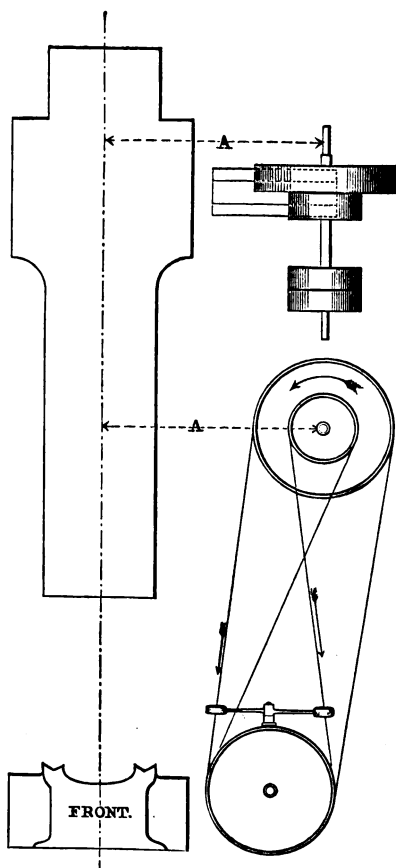
The counter-shaft must be set for each machine as per following table, to allow the belt shifters to throw the belts properly.

In no case can the centre of counter-shaft be vertically over the centre of pulley shaft on machine.

NAME OF PLANER.	COUNTER-SHAFT.		DISTANCE <i>A</i> FROM CENTRE OF BED OF MACHINE TO CENTRE OF COUNTER-SHAFT.
	SPEED.	DIAMETER AND BELT OF FAST AND LOOSE PULLEYS.	
20"	300 rev.	8" Diam. 4" Belt.	27½"
25"	256 "	12" " 4" "	35"
30"	236 "	14" " 4" "	41½"
36"	220 "	16" " 4" "	47½"
42"	209 "	18" " 6" "	52½"
48"	228 "	18" " 7" "	58"
54"	228 "	18" " 7" "	61"
60"	207 "	20" " 7" "	69½"
72"	198 "	22" " 7" "	78½"
84"	190 "	24" " 7" "	90"

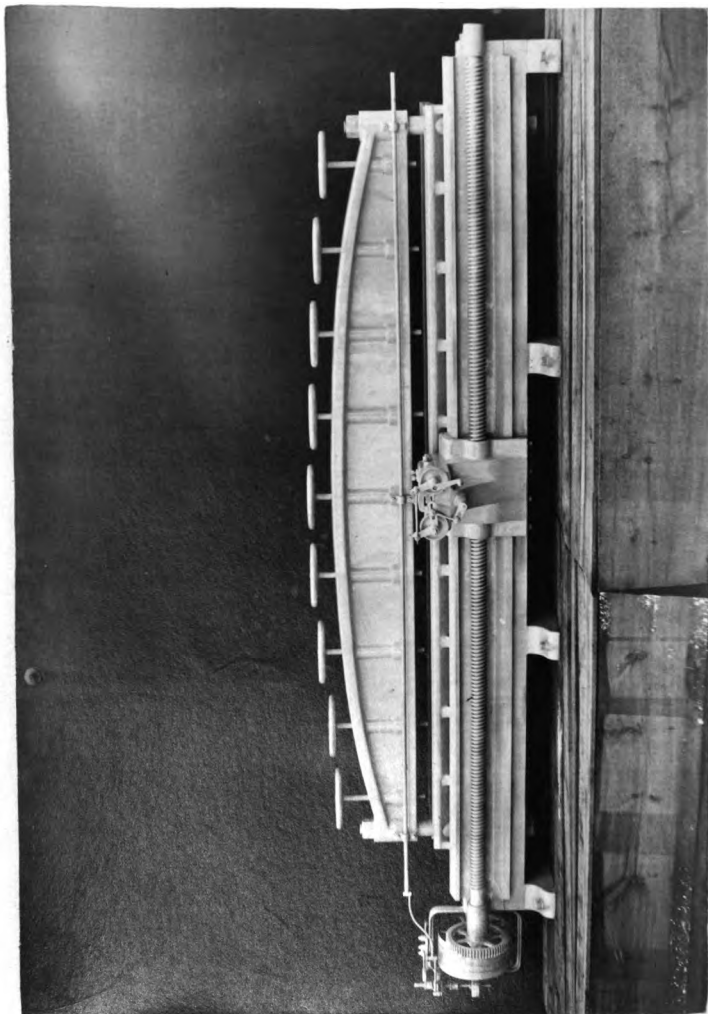
MARCH, 1871.

The 72-inch and 84-inch Planing Machines are provided with means of raising the cross head by power.



PLAN AND ELEVATION.—SHOWING BED OF MACHINE AND POSITION OF COUNTER-SHAFT.



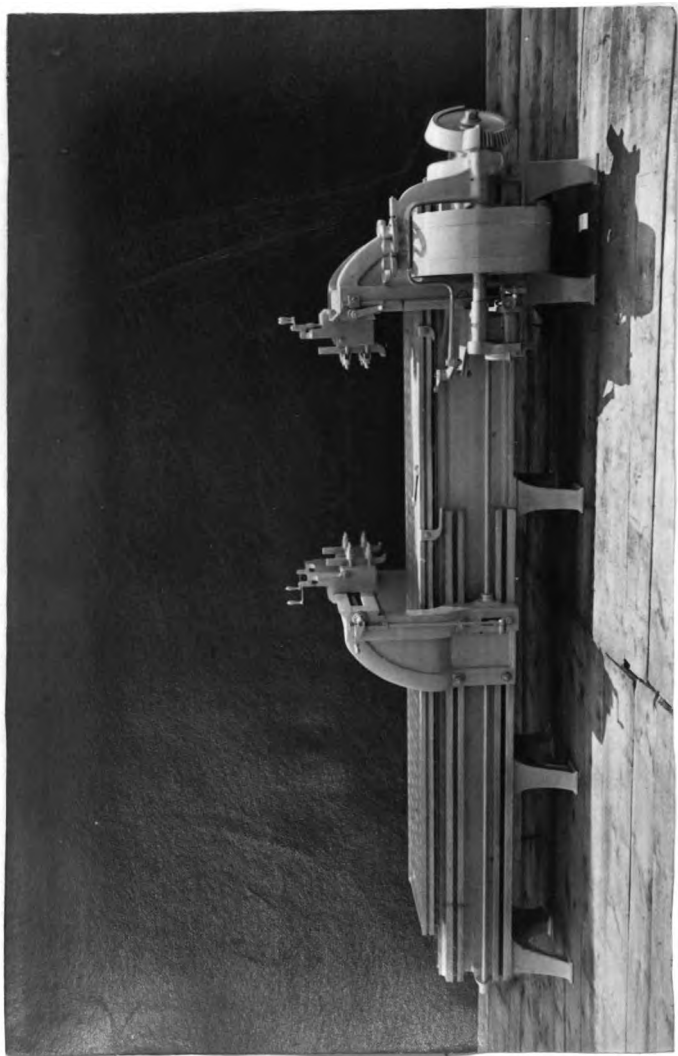




## PLATE PLANING MACHINE,

Arranged with table to carry plate 14 feet long, with powerful holding-down bolts, clamping the sheet on a wooden bolster, which may be curved to form of ship plates. Cutter head driven by screw, carrying two tools, taking cut both ways and self-operating in feed.

**I**T has been found that boiler plates, planed to a bevel on their edge, can be worked with more certainty and make much better work at a very much less cost than if chipped by hand. It was thought that the same result might be obtained by using bevel shears which should cut the edge on an angle, but the work done by them was found to be so ragged as to be practically worse than if left square. The Plate Planing Machine bevels the edge and squares up a narrow calking surface. For building **For ship work.** iron ships this machine is invaluable, it being able to either plane the sheets before or after being bent. Fast and loose pulleys on counter 12 inches diameter, 4 inches face, speed 373 revolutions per minute. **Speed.**



## ROD-PLANER.

For planing locomotive connecting rods arranged with two sets of uprights and cross heads, with double saddle on each cross head. Table driven by patent spiral driving gear, so arranged as to move table at same speed each way, and, taking cut in both directions, is adjustable in length of rod to be planed from  $3\frac{1}{2}$  to 10 feet. Self-operating feed to saddle will plane both ends of two connecting rods at the same time. Fast and loose pulley on counter-shaft, 14 inches diameter, 4 inches face, should make 236 revolutions per minute. Ball and socket hangers for over-head shaft; wrought iron work planed to standard sizes and case hardened.

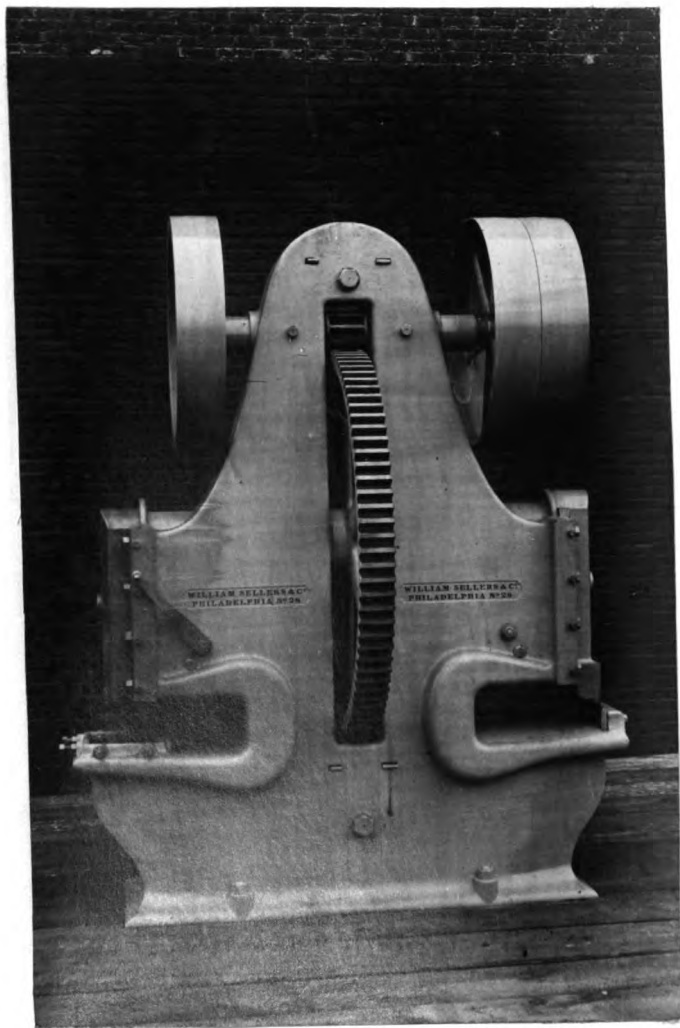
**A** SPECIAL tool designed for use in locomotive shops; useful in planing the ends of connecting rods, but is applicable to all kinds of stub-ends for stationary-engine work as well; can also be used for planing guide bars for locomotives, in which case it will work to advantage on four guide bars at once. It is a solid, substantial tool, capable of taking same cut as our regular 30 inches by 30 inches planer, and has all the advantages of our patent planing machine. In using this machine for a long time on short strokes, it is advisable (as with any planer) to pay more attention to the oiling of the V's than if it was on long work, as at short strokes the oil is not so well distributed by the self-oilers; so an occasional examination of the spiral pinion, to see that it is greasy (not slushed with oil), is advisable.

Spiral pinion.

Oiling the ways.

The introduction of this machine has materially cheapened the production of locomotive connecting rods and similar work. Speed of counter same as for 30 inches by 30 inches planer, viz., 236 revolutions of fast and loose pulleys, which are 14 inches diameter, 4 inches face.

100 *PUNCHING AND SHEARING MACHINE COMBINED.*



## PUNCHING AND SHEARING MACHINE COMBINED.

Punch and shears driven from the same shaft; independent stop motion to each, so that they will always rest at their highest point; can punch a hole in the centre of a plate  $35\frac{1}{2}$  inches in diameter, and can shear in width  $20\frac{1}{2}$  inches; overreach of jaw 20 inches for rivet punches and shears, and  $17\frac{3}{4}$  inches for washer punches.

IN designing this machine the requirements of ordinary boiler work were in view. The shear is intended for cutting plate iron of usual thickness for boilers; will shear  $\frac{5}{8}$ -inch plate. The punching side has its dies so arranged in a holder as to permit the punching of flanges of heads which are as small as 12 inches; the punching being done from the outside or marked side of the head, and flanges turned out on end of flues can be punched vertically. We send with each machine a sample set of punches and dies intended for boiler plate of  $\frac{3}{8}$ -inch thickness, on which it will be seen that the holes in the dies are made larger than the punches on the following formula, expressing the diameter and thickness in sixteenths of an inch.

Punching  
boiler heads.

Sample punches  
and dies.

The diameter of the die hole = diameter of punch, plus  $\frac{2}{16}$  the thickness of the plate ( $D = d + 0.2 t$ ). Thus, for iron plate  $\frac{6}{16}$  of an inch thick, the diameter of the punch being  $\frac{1\frac{3}{8}}{16}$  of an inch, the diameter of the die hole will be 15.2 sixteenths of an inch,—say  $\frac{1\frac{5}{8}}{16}$  inch. This method of making the die hole larger produces a taper hole in the plate, but allows the punching to be done with less consumption of power and, it is said, with less strain on the plate. We do

Formula for  
size of die  
hole.

## 102 PUNCHING AND SHEARING MACHINE COMBINED.

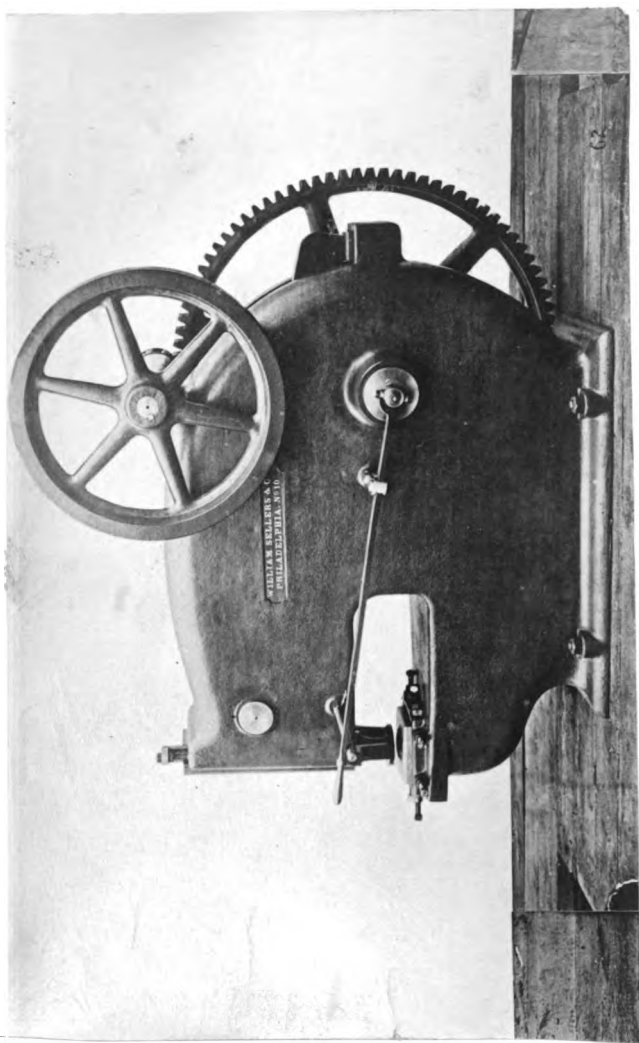
No strippers  
sent with  
machines.

not adapt any strippers to this machine, as the character of work makes it necessary for the users to arrange them to suit their special work. To run these machines efficiently, the fast and loose pulley on the machine should make at least 120 revolutions per minute: this will punch 12 holes to the minute; if a faster speed is admissible on the work, the speed of pulleys can be increased. Determine number of punch strokes to the minute, and multiply by 10 for speed of pulleys. By means of the independent stop motion, one stroke can be made at a time on either side of the machine without stopping the machine itself, or interrupting the work being done on the other side. In this respect it is as convenient as two entirely distinct machines.

Crank motion  
punching  
machine.

We also arrange from same pattern a punch and shear with less overreach; the shear blades placed for cutting off light bar iron, and the punch side arranged for washer punching, or the punching of  $\frac{3}{4}$ -inch thick bars for car work. When single punches or shears are required, we can stop off part of the frame and produce independent machines, useful for some special purposes, when it is required for convenience to have the punch and shear in separate parts of the workshop.







## PUNCHING MACHINE (LEVER).

Punch operated by a heavy wrought iron lever within the housing. Independent stop motion, so that the punch will rest at the highest point of its stroke. Can punch a hole in the centre of a plate 52 inches diameter, and has a stroke of  $1\frac{1}{2}$  inches.

WE make also similar power of machine with greater overreach; can punch a hole in the centre of a plate 66 inches in diameter.

It is evident that in all punching or shearing machines driven by a belt, there must be a conversion of the rotary motion of the driving pulley into a reciprocating motion of the punch or shear blade.

To obtain the requisite force, many revolutions of the driving pulley must occur to one stroke of the punch. In crank machines, the whole pressure of the cut comes directly on the crank pin, which must perform a good portion of its revolution under this heavy strain at whatever speed the crank shaft may be running. This limits the power of such machines to the practical pressure sustainable on a given surface at a given speed of motion. When the vertical slide which carries the punch is operated by a lever, the sliding motion of the part of the lever in contact with the vertical slide is almost inappreciable: the pressure extends over large surface with little motion; so with the fulcrum pins over which the lever works; with very little and very slow motion of these parts much pressure is admissible, while the long end of the lever is operated upon by the lifting cam acting under comparatively light pressure. Added to this economical

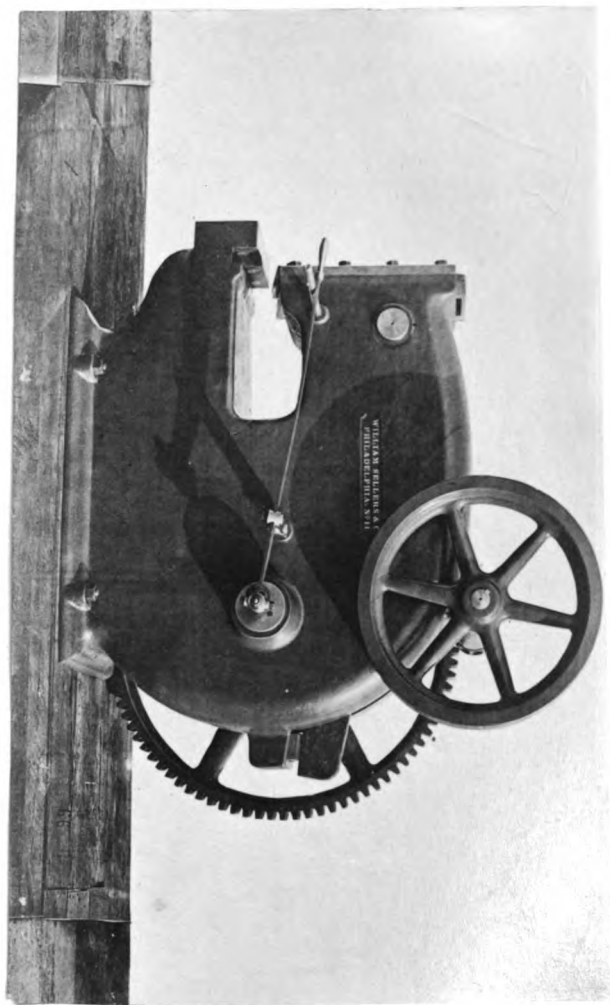
Pressure on  
crank.

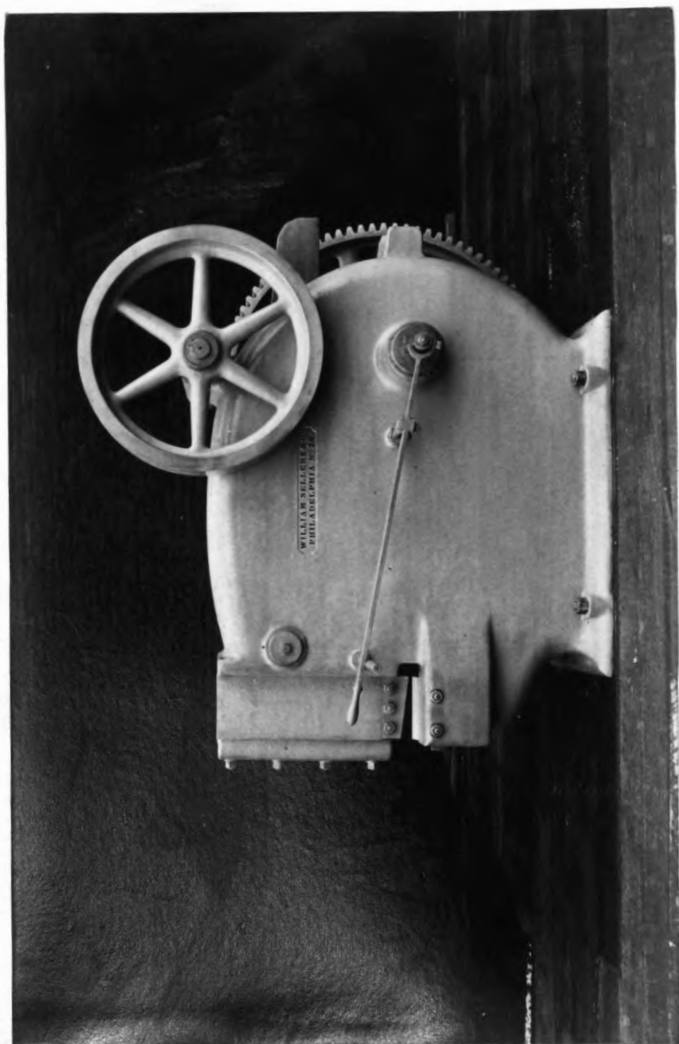
Less friction  
with lever  
machine.

use of power, with diminished frictional resistance, comes the possibility of so shaping the lifting cam as to cause the motion of the punch to be uniform through the whole of its stroke, to return quickly, and to dwell during any required portion of the revolution of the crank shaft. So that, in comparison of machines using crank and lever, in both cases the same gearing between pulley and work, making the same number of strokes of the same length per minute, there is a capability of punching larger holes when a lever is used instead of a crank. The lever punches, as made by us, are provided with a box at back of frame, to hold a block of wood to receive the fall of the tail end of the lever on its quick return motion; the regulation of the height of this block adjusts the length of stroke of the punch, thus enabling it to be set close to the sheet or bar being punched. These machines are being used to great advantage in heavy boiler and ship-building operations; and with proper adjustment of size of die to size of punch (see page 101), the holes for flues may be punched in flue sheets of boilers and the flues set to place without the holes requiring reaming. The speed of this machine, which has pulley 36 inches diameter, 7 inches face, should never be less than 120 revolutions per minute. For speed of pulley, if required faster, multiply strokes of punch required by 10, which gives speed of pulley.

Shape of cam.

Regulation of  
length of  
stroke.





## SHEARING MACHINE.

Shear operated by a heavy wrought iron lever within the housing. Independent stop motion, so that the blades will rest open; over-reach of blades 26 inches; vertical motion of blade  $1\frac{1}{2}$  inches.

**S**AME power of machine, also made with an over-reach of 33 inches.

For remarks on theory of operation, see page 105, Punching machine.

All that is said in reference to theory of construction holds good either for shearing or punching, as also for speed of pulleys.



## BAR SHEAR—LEVER PATTERN.

Shear operated by a heavy wrought-iron lever within the housing; independent stop motion, so that the shear will rest at highest point of its stroke; shear blades  $9\frac{3}{4}$  inches long; will cut  $1\frac{1}{2}$ -inch by 6-inch iron. Single driving pulley on machine, 36 inches diameter, 7 inches face, which should run 144 revolutions per minute.

**T**HIS machine is the same in general principle as the shearing machine and punching machine, pp. 101, 102; with the difference in the arrangement of the fulcrum pin, which is mounted in an eccentric, so as to admit of the adjustment of the same blades for either thick or thin iron.

Adjustment of  
blades.

## BENDING ROLLS,

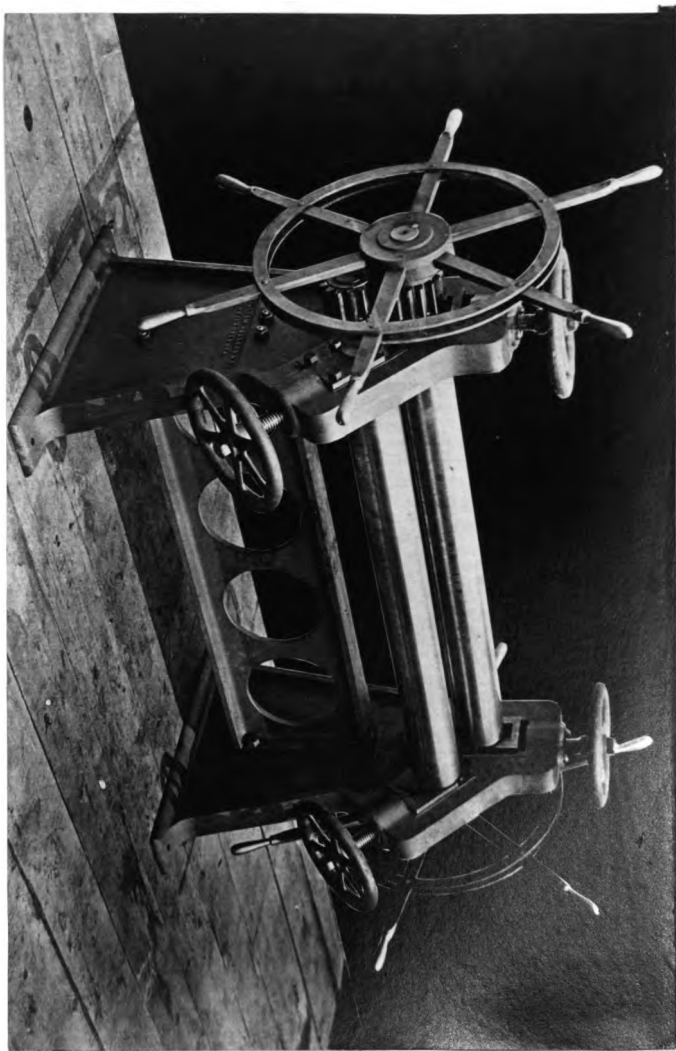
Made of best gun iron, for boiler plate; with strong iron frame, self-supporting top, and side rolls adjustable, to set on floor without foundations, with rolls 5 inches in diameter, 4 feet 6 inches long.

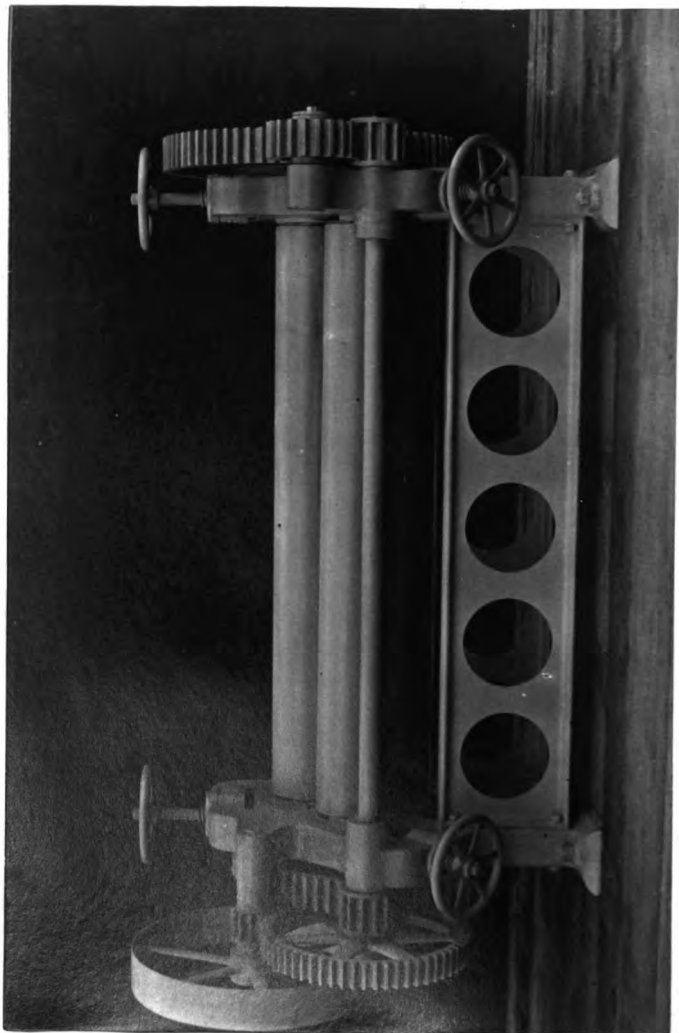
Same machine with all the rolls adjustable, housings and boxes complete, fitted to bolt on foundations.

Rolls 8 inches diameter, 6 feet 1 inch long.

“	9	“	“	“	6	“	1	“	“
“	9	“	“	“	8	“	1	“	“

THE first machine described in the above specification is intended for tank work, bending iron of not over  $\frac{3}{16}$  inch thick; is admirably adapted for tank work, and can be used to advantage in coppersmith shop for rolling up pipes. The larger rolls are of the usual hand-working kind, and require pits at each end of the rolls for the lever arms to work in. The housings are independent, and must be secured to foundation.







## POWER BENDING ROLLS,

Arranged with two pinching rolls, set one directly over the other, the bending roll movable at an angle to the pinching rolls. Pinching rolls geared at opposite ends, so that they are always correctly in gear while driving. The top pinching roll removable through housings at one end, so as to permit the bending up of flues. Over-head shaft with ball and socket hangers and three pulleys, 24 inches diameter, 5 inches face, for reversing by open and cross belts, which pulleys should make 180 revolutions per minute, requiring on main line a driving pulley 15 inches face.

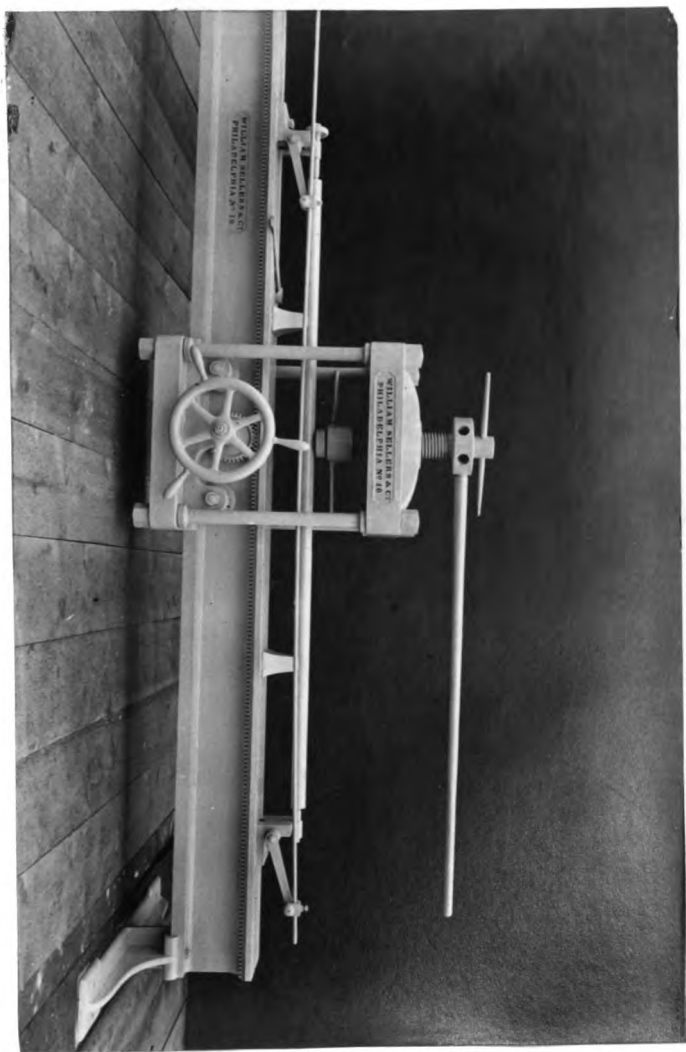
**R**OLLS arranged as above present the advantage of being able to squeeze the plate between the two pinching rolls and bend nearer to the edge of sheet than can be done with three rolls set in the usual manner, *i.e.* two on a horizontal plane and one over the space between these rolls. Bend near to edge.

We are prepared to make Power-bending Rolls for ship work, with four rolls in the system adjustable by power in height; these rolls are massive and can be used for bending plates 1 inch thick and 14 feet wide; will bend cylindrical or in-wind, while the sheet is passing straight (not diagonally) through the machine. These rolls can also be used for straightening plates in a much more thorough manner than can be done with hammers: they are intended for ship work. All the rolls have centre supports. We also make a similar set of 4 rolls for boiler work, to take in plates 11 feet wide, having all the advantages of the above. For large boiler plates.

## STRAIGHTENING MACHINE,

With bed 20 feet long, bending screw traveling the whole length, and the work to be straightened stationary, with centres for shafting to elevate and depress; with a full set of bending blocks; the whole capable of straightening a shaft 6 inches in diameter when cold. Wrought iron work case hardened.

**T**HIS is an indispensable machine in any establishment where shafts are turned. The work having been centred, can in this machine be straightened quickly and thus made ready for the lathes.



## WHEEL QUARTERING MACHINE.

Quarters from 5 inches up to 13 inches radius of crank, either right or left hand crank lead; bores both crank holes at the same time from the outside of wheel, with self-acting adjustable feeds. Wheels and axle supported, adjusted, and secured upon tread of wheel, so as to insure great rigidity while being bored; over-head shaft with ball and socket hangers and one fast and two loose pulleys, 24 inches diameter, 8-inch face for 4 inches shifting belt, speed 86 and 120 revolutions per minute. Full set of wrought iron wrenches. Wrought iron work case hardened.

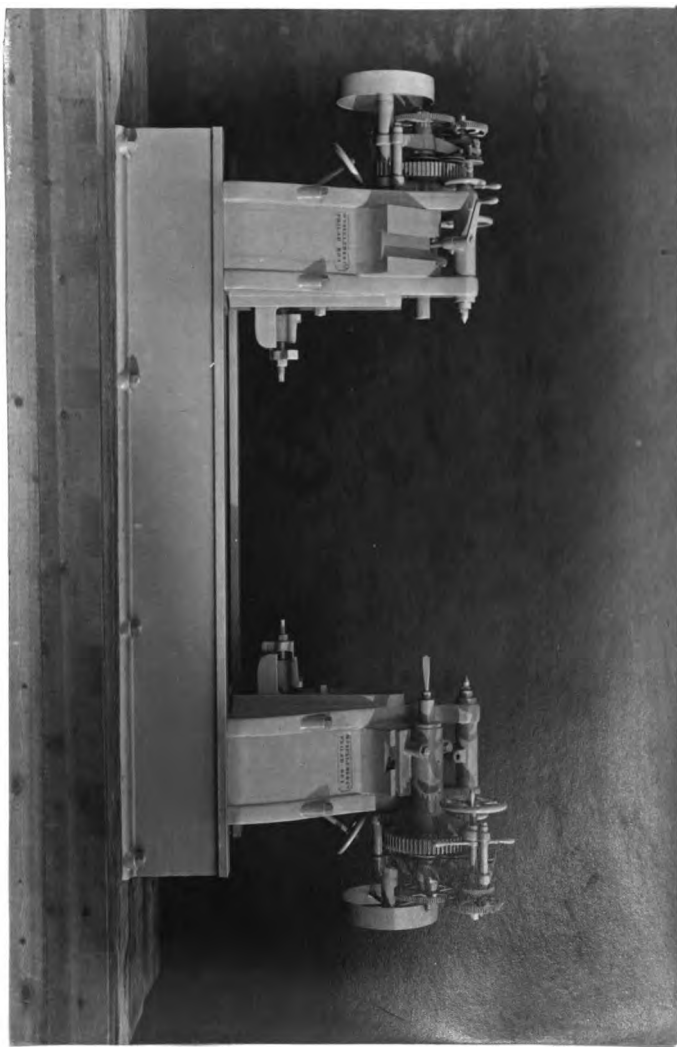
**T**HE introduction of small short-stroke engines for mine purposes calling for some ready means of quartering wheels with a crank throw of only 5 inches for engines of 10-inch stroke, we have so arranged this machine as to quarter from 5 inches to 13 inches radius of crank, and to bore either for right or left hand lead with equal accuracy. The boring spindles are outside of the wheels, and bore both crank holes at the same time, each spindle being driven separately and provided with adjustable automatic feed, so as to apply in practice the principle alluded to in our remarks on boring machines (page 9), in roughing out the holes with fine feed, but finishing with a wide feed and light cut. The wheels on their axle are carried by their tread on adjustable shoes, which hold them rigidly in place, while the centres control position of axis only; this insures great stability, and entirely precludes the possibility of the wheels shifting under-cut or springing from pressure of cut. The bed is adapted in length for either wide or narrow gauge.

Bore from outside of wheel.

Holding wheel.

May be used as a horizontal drill.

The machine is not only valuable as a quartering machine, but may be used to advantage as a horizontal drill for other purposes. For speed of counter-shaft, see specification above.



## SLABBING MACHINE,

Arranged with bed, table, and uprights, like planer, with a capacity of 25 inches by 25 inches; table 12 feet long. Table operated by spiral pinion in same manner as on our patent planing machine. Spindle to carry cutter  $4\frac{1}{2}$  inches diameter, 4 inches wide, powerfully geared, and adjustable in height.

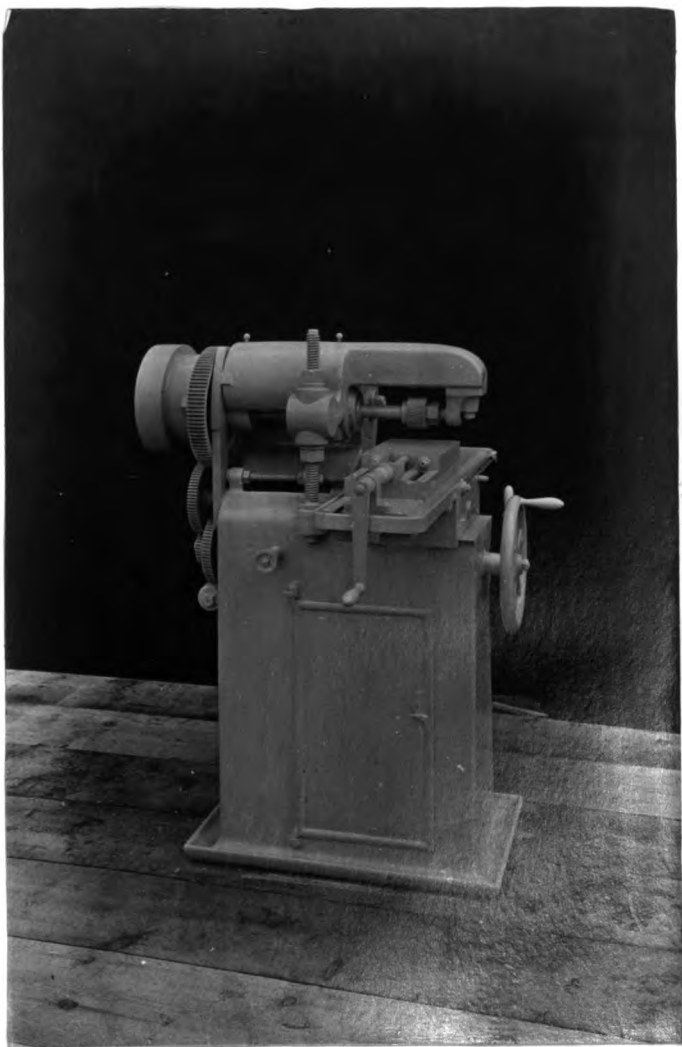
**T**HIS tool is especially adapted to mill the flats of connecting rods and similar work. When used for cutting cast iron, larger cutters than  $4\frac{1}{2}$  inches diameter can be used to advantage. The feed is variable between the extremes, and the table has a means of moving it readily by hand, with an automatic stop motion to throw out the feed at the end of the stroke. The table is provided with a dish extending entirely around its edge, to catch the water used in cooling the cutter. The fast and loose pulleys on the machine are 20 inches diameter, 3 inches face, and should make 114 revolutions per minute.

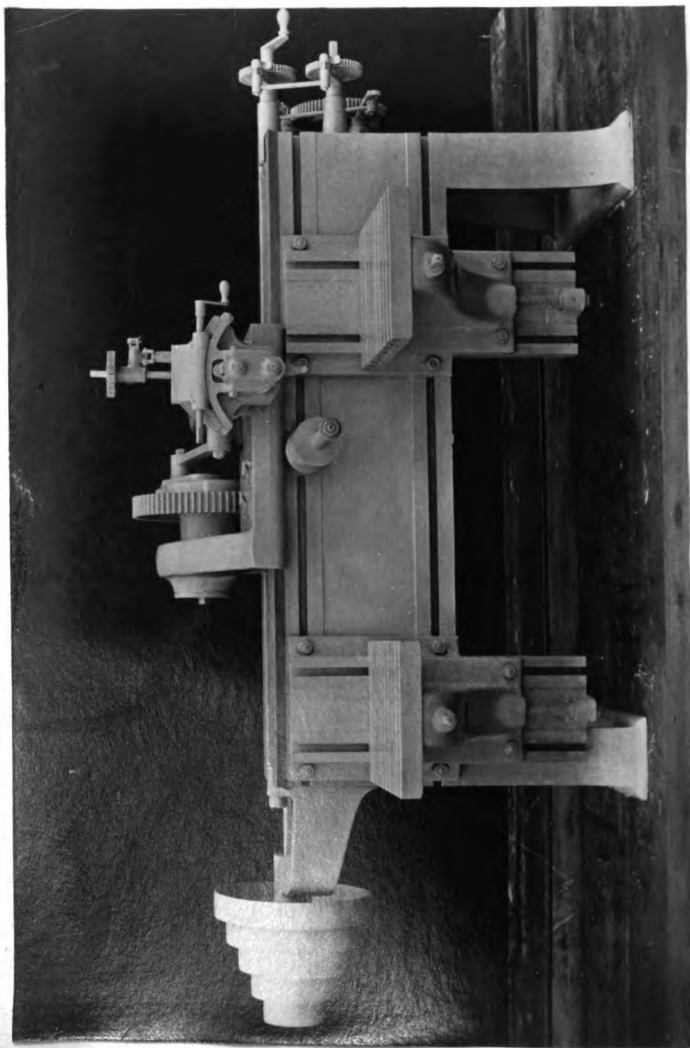
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## MILLING MACHINES,

With 4 inches vertical and  $4\frac{1}{2}$  inches longitudinal adjustment; with 14 inches transverse feed movement, the latter adjustable to every speed between the fastest and slowest; the vertical and transverse adjustment by double screw to take up any play; adjustable stop motion, clamp vice, over-head shaft, pulleys, ball and socket hangers, and wrought iron wrenches complete. Wrought iron work case hardened.

**T**HIS milling machine is very rigid, and capable of taking heavy cuts; very useful on gun work; in machine shop, can be used to advantage in fluting or grooving taps and reamers, etc., as also in keyseating short shafts.







## SHAPING MACHINE,

With shaping bar moved by variable crank, with quick return motion; feeds self-acting in all directions; self-acting motions for straight, curved, vertical, and angular work, and internal curves; the planing tool moving in every direction, and the work stationary. Tool holder, with segment wheel and worm, two tables for holding the work adjustable, longitudinally and vertically, two arbors, two pairs of cones; over-head shaft, pulleys, and ball and socket hangers; cone pulleys, turned inside so as to be perfectly balanced; a full set of wrought iron wrenches, and all wrought iron work finished to standard sizes and case hardened.

With stroke of bar 9 inches to plane, in length 36 inches.

"	"	"	12	"	"	"	"	48	"
"	"	"	16	"	"	"	"	66	"
"	"	"	20	"	"	"	"	84	"

Centre head on bar with index plate.

Clamping vice.

THE shaping machine, called sometimes compound planer, is one of the modern machine tools of such great convenience and universal application that it has become essential even in shops of limited capacity. The manner in which it performs its work—viz., the work being stationary and the tool held on the end of projecting bar being made to move—involves conditions requiring unusual care in design and construction.

Work stationary.

The peculiar device invented by Mr. Whitworth, of Manchester, England, and first applied by him to these tools, of so arranging the driving crank motion as to give a slow motion of tool under-cut and a quick return, has come to be universally acknowledged as the proper means of operating the planing tool. Our shaping machine has this so-called Whitworth motion, constructed in such a manner as to make the

The Whitworth motion.

Quick return  
to tool.

Feed always at  
end of stroke.

Inspection of  
tools.

Speeds.

cut in about two-thirds of the revolution of crank wheel and the return stroke in the remaining one-third of a revolution. We have retained all the essential particulars of the machine as made by Mr. Whitworth, and added many conveniences, adapting it to a wider range of work, increasing its power of cut, and so arranging the driving power and feed as at all times and in every motion to insure the feed occurring at end of stroke, and never under-cut. This is an important feature. The machines, when built, are submitted to rigid examination and tests to be sure that they plane true in square and in parallelism, errors being more apt to creep into this class of tools than in any other, so that users will find that the extra cost required to produce a machine which is correct in adjustment and in work is amply compensated for in excellency of performance. The counter-shafts of these machines are each arranged with two speeds, one fast one for short work, and one slow one for greater length of cut and for planing steel. These differences of speed are in addition to the changes incident to the cone pulleys.

Our 9-inch shaping machine has on its counter 6 inches by  $2\frac{1}{2}$  inches fast and loose pulleys, which should make 400 revolutions per minute, and a pair of 10 inches by  $2\frac{1}{2}$  inches fast and loose pulleys, which should make 150 revolutions.

Our 12-inch machine has 8 inches by 3 inches, fast and loose, 300 revolutions, and 14 inches by 3 inches, fast and loose, which should make 100 revolutions.

Our 16-inch machine is provided with 10 inches by 4 inches, fast and loose, to run 380 revolutions,

and 18 inches by 4 inches, fast and loose, to run 135 revolutions.

We also make clamping vices, adapted to each size of machine, for the convenience of holding many kinds of work; but in large establishments, where there is a repetition of planing on the same kind of work, it is customary for the user to adapt to his work special holding devices.

The machines are provided with a spindle and chucking cones, for doing circular work, such as planing up the bosses or hubs of rocker arms, but in addition to this much work can be more conveniently held in independent centre heads. We arrange centre heads for each size of machine, with under plates carefully divided, and with tangent wheel and worm for feeding on circular work. These centre heads are supported on a bar, so arranged as to be held in line or at right angles to the planer motion. Both the clamp vice and centre heads are classed as extra tools, and not included in the price of the machine, inasmuch as where several shaping machines are used in one shop, it is not always deemed advisable to furnish each with a full set of extra tools. Inquiry is frequently made for shaping machines with long bed and double planing head, to operate on connecting-rod ends and work of a like character. We make a solid base casting, upon which we bolt the beds of two shaping machines, so arranged as to insure their being at all times in line, and capable of being operated as distinct machines or in conjunction as one machine. We deem this preferable to one long bed with two heads on it, driven from one cone pulley.

This we term our **DOUBLE SHAPING MACHINE**.

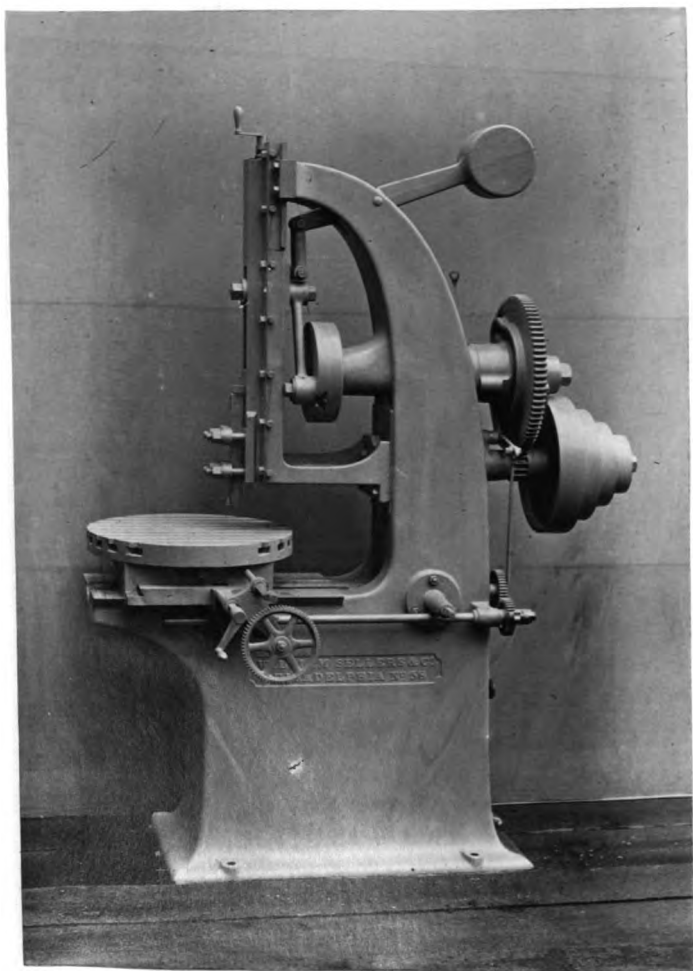
Clamping vice.

Spindle for curved work.

Centre heads.

Extra tools.

Double heads.



## SLOTING MACHINE,

With slotting bar counterbalanced so as to run without jarring; is driven by a variable crank, with quick return motion; bearing for slotting bar adjustable vertically to suit the different heights of work; compound tables with circular plate and centering stud; feeds self-acting in all directions; over-head shaft, iron cone pulleys turned inside, so as to be perfectly balanced; ball and socket hangers, and wrought iron wrenches. Wrought iron work case hardened.

To admit 30 inches diameter.  $7\frac{1}{2}$ -inch stroke.

"	"	36	"	"	9	"	"
"	"	48	"	"	12	"	"
"	"	60	"	"	15	"	"
"	"	72	"	"	18	"	"

**T**HESE machines, as in the case of our shaping machines, are provided with the so-called "Whitworth motion" to the slotting bar, giving a slow movement under-cut and a quick return motion. They are adjustable in length of stroke and in position of the slotting bar in height from the table upon which the work rests, and the bearing or slide in which the slotting bar works is also adjustable, to suit the different heights of work and to enable the bar to be guided as near to the work as possible, thus to give great steadiness to the motion. In some kinds of work this adjustable bearing may be set down near to the table, and thus give a firm backing to the tool during the whole of its stroke. The slotting bar is counterbalanced; this effectually prevents jar in running, the lost motion being all taken up by the counterweight in the direction of the force exerted in making the cut. The compound table is provided with a circular table, operated by wheel and tangent screw with self-operating feed. An important feature of this machine is the arrangement of its feed motion, which insures the feed always occurring at the top of the stroke and never during the cut. The great ad-

Whitworth motion.

Adjustable bearing.

Slotting bar counter-balanced.

Table.

Feed.

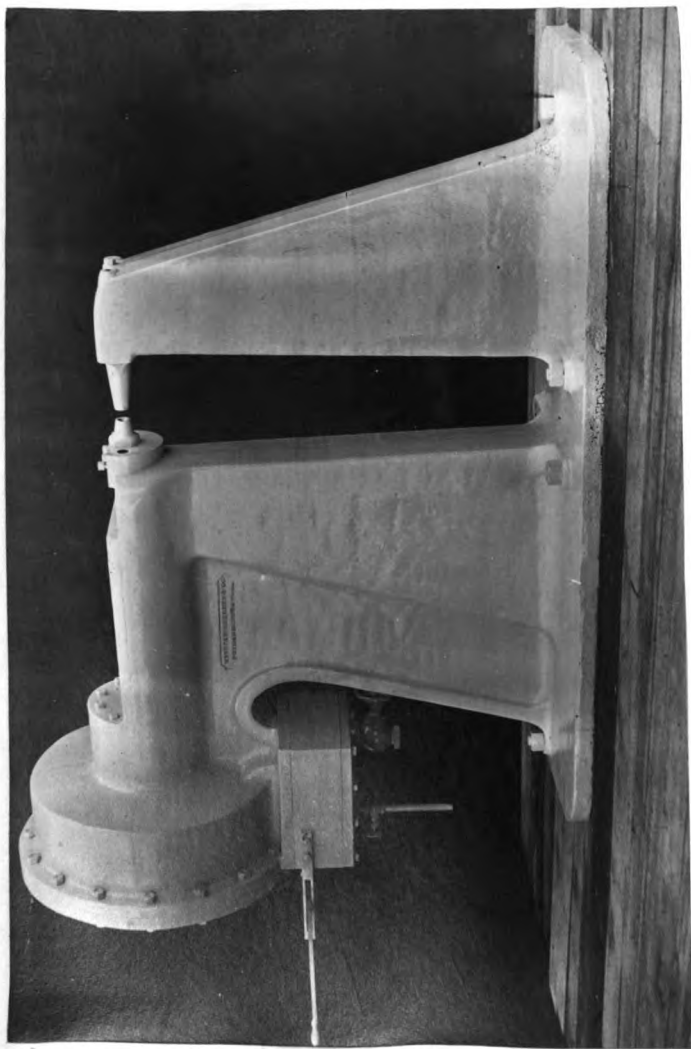
**Handles.** vantage of this will be manifest when it is remembered that should the feed occur at lower end of stroke the rigid tool will drag back with a pressure due the amount of feed. The working handles to operate feed by hand are on all these machines, even on the largest size, within easy reach of the workman, and in such a position as to enable him to readily see the point of the slotting tool as he adjusts the feed,—an advantage quickly appreciated when the machine is used to slot to scribed lines. Apart from the stability of the machine, and the great care taken in the construction, these machines possess advantages over any other style we have seen, doing more and better work with the same grade of workman. This advantage obtains mainly from the exceeding convenience of handling. There is scarcely any machine tool requiring more close watching on the part of the workman on the class of work it is required to do; it seldom takes long cuts, it generally being but a little while under power feed at a time, and then its amount of production, all other things being equal, depends upon the readiness with which the attendant workman can do his part of the movements in adjusting and readjusting the work in various positions and keeping the tool under-cut as much of the time as possible.

**Advantages.**

For speed of counter-shaft of the various machines we give the following table :

Size of machine.	Diameter and Face of Fast and Loose Pulleys.		Revolutions per Minute.
30 inches	10 inches	by 2 $\frac{3}{4}$ inches	260
36 "	12 "	" 3 $\frac{1}{8}$ "	226
42 "	14 "	" 3 $\frac{1}{2}$ "	204
48 "	16 "	" 4 "	186
60 "	20 "	" 4 $\frac{1}{2}$ "	157
72 "	24 "	" 7 "	130







## STEAM RIVETING MACHINE.

Operated by direct action of steam; piston and riveting ram, wrought iron, in one piece; balanced valve; piston drawn back by expansion of steam used in riveting. Can rivet in circular shells, sheets 5 feet wide; can drive all rivets in corners of square fire boxes, also the rivets fastening waist of locomotive boilers to fire box. Tension of steam for driving  $\frac{3}{4}$ -inch rivets, 60 pounds boiler pressure.

### REMARKS ON THEORY OF CONSTRUCTION AND OPERATION.

FROM *The Railroad Gazette*, August 3, 1872,  
we extract the following remarks on "Direct-Acting Steam Riveting":

#### "DIRECT-ACTING STEAM RIVETING MACHINES.

"In presenting a full-page illustration of the steam riveting machine designed and built by Messrs. William Sellers & Co., of Philadelphia, we take occasion to make a few remarks on the principles involved and the practical use of such machines. What is manifestly required in perfect riveting is, that the metal of the rivet while hot and plastic shall be made to flow into all the irregularities of the rivet holes in the boiler sheets, that the surplus metal be formed into heads as large as need be, and that the pressure used to produce these results should not be in excess of what the metal forming the boiler shall be capable of resisting. Flow of solids.

"It is well known that metals, when either cold or hot, if subjected to sufficient pressure, will obey almost exactly the same laws as fluids under similar

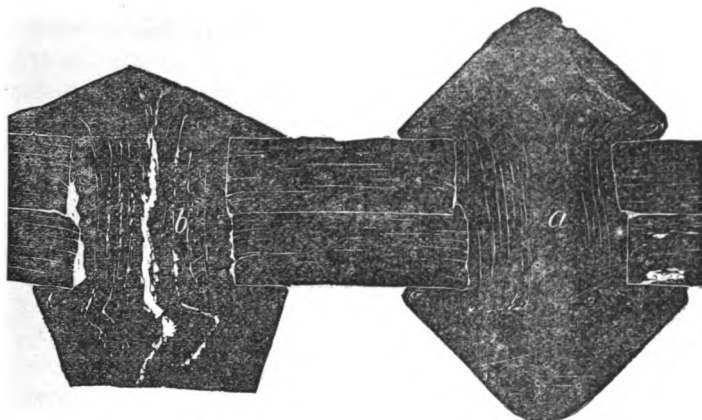
Flow of solids. conditions, and will flow into and fill all the crevices of the chamber or cavity in which they are contained. If, therefore, a hot rivet is inserted into the holes made in a boiler to receive it, and is then subjected to a sufficient pressure, it will fill every irregularity of the holes, and thus fulfill one of the conditions of perfect riveting. This result it is impossible to accomplish with perfection or certainty by ordinary hand riveting, in doing which the intermittent blows of an ordinary hammer are used to force the metal into the holes. With a direct-acting steam riveting machine, however, an absolutely certain and continuous pressure can be imparted to each rivet, so as to force the hot metal of the rivet into all the irregularities of the holes, in the same way as a hydraulic ram will cause water to fill any cavity, however irregular. In order to test and also illustrate the relative advantages of machine and hand riveting, we have had two plates riveted together, the holes of which were purposely made so as not to match perfectly. These plates were then planed through the centre of the rivets, so as to expose a section of both the plates and rivets. From this an impression was taken with printer's ink on paper and then transferred to a wooden block, from which our engraving was made. *a* was put in by one of Messrs. Wm. Sellers & Co.'s machines, and *b* by hand. It will be observed that the machine rivet fills the hole completely, while the hand rivet is very imperfect. The experiment was tried several times, with similar results each time.

Continuous  
pressure.

Test.

"The hand rivets, it will be observed, fill up the holes very well immediately under the head formed by the hammer; but not sufficient pressure

could be given to the metal—or at least it could not be transferred far enough—to affect the metal at some



distance from the head. So great is this difficulty that in hand riveting much shorter rivets must be used, because it is impossible to work effectively so large a mass of metal with hammers as with a machine. The heads of the machine rivets are, therefore, larger and stronger, and will hold the plates together more firmly, than the smaller hand-riveted heads.

Shorter rivets  
by hand.

“Direct-acting steam riveting machines give a uniform force, if the steam pressure used be uniform, and they give such pressure as is needed, regardless in a measure of the amount of metal forming the rivet. These machines have been made on two general principles. In the English machines, a comparatively light piston of large diameter acting upon a not very large or heavy riveting ram is made to do its work by the pressure of steam alone. In the machine illus-

Weight of ram.	<p>trated, a very heavy piston and riveting ram are made to do the work by the combined effect of steam pressure and momentum. The ram and piston are of wrought iron in one solid forging, and weigh, when finished, over one ton. With the increased weight of the riveting ram a less diameter of steam cylinder is needed. Thus, it is said that one of these machines with a steam cylinder 31 inches in diameter working alongside of an English machine with a steam cylinder 36 inches in diameter does the same kind of work from the same steam boiler, and yet requires a shorter stroke, thus using less steam to accomplish the same result. In practice, it has been found that for locomotive boilers using <math>\frac{5}{8}</math>-inch rivets about 60 pounds pressure per square inch does the best work.</p>
Pressure of steam.	<p>“The machine illustrated is so arranged as to enable all the rivets about the ordinary locomotive boiler to be driven with ease; that is, it will rivet the corner seams of the fire box and drive the rows of rivets where the waist joins the outer shell of the fire box. In the practical working of this machine it may be well to mention that the rivets are inserted from the outside of the boiler, not, as in hand riveting, from the inside. The boiler, suspended in slings attached to a crane, is drawn up to the riveting hammer, and the first blow struck carries the boiler, pushed by the rivet head, up to the post, and thus tends to close up the sheets as the head is being formed on the inside of the boiler. The second blow is then delivered with the boiler pressed up to the post or stake, and the steam pressure retained until the rivet has had time to cool.</p>
Drive all the rivets of locomotive boilers.	<p>Thus two blows are given to each rivet; and in this manner, allowing time for each rivet to cool under pressure, five rivets per minute can be driven. The</p>
Method of using.	
Two blows to each rivet.	

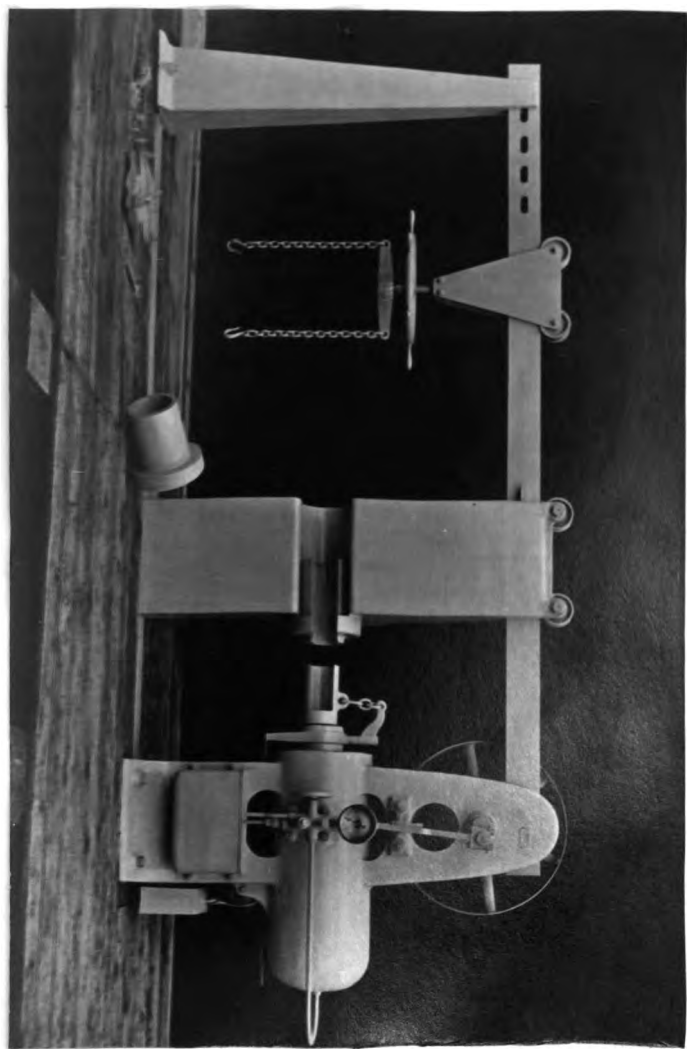
arrangement of valve is such as to enable the charge Valve.  
of steam used in riveting to be utilized in its expansion to draw back the ram."

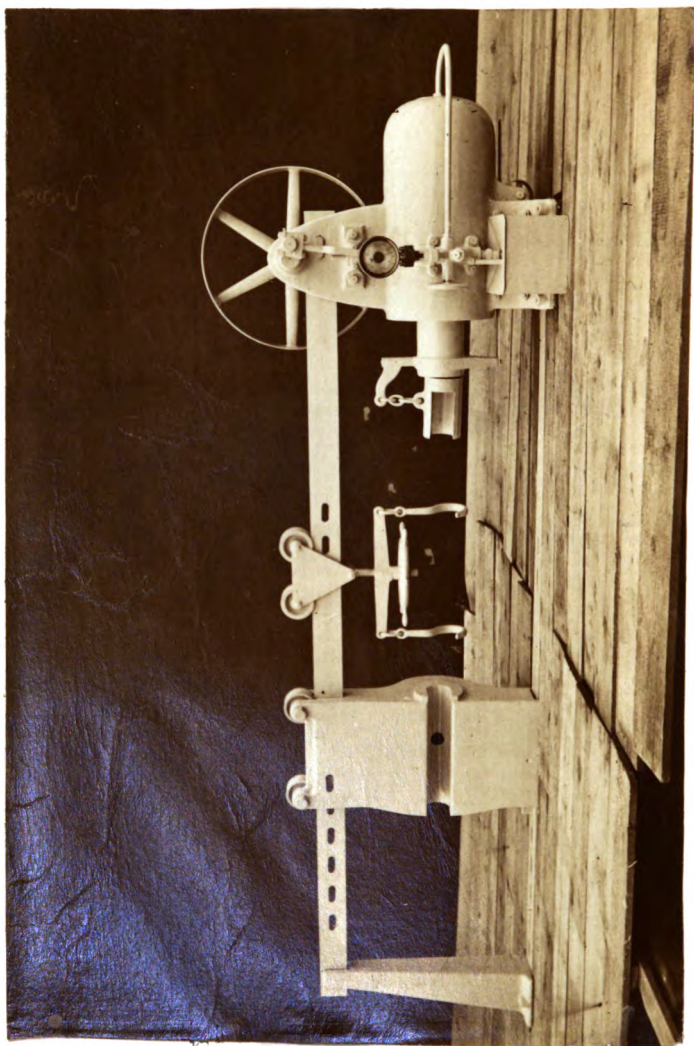
To drive rivets by hand, two strikers and one helper are needed in the gang, besides the boy who heats and passes the rivets; to drive each  $\frac{1}{8}$ -inch rivet, an average of 250 blows of the hammer is needed, and the work is but imperfectly done. With steam riveting machine, two men handle the boiler, and one man works the machine; thus, with the same number of men as is required in riveting by hand, five rivets are driven each minute. The superior quality of the work done by the machine would alone make its use advantageous; but to this is added greatly increased amount of work done. In setting up these machines, it is essential that they rest on good substantial foundations, so as to prevent motion of the machine, there being a constant tendency to slide the machine under the impetus of the striking ram. We furnish with the riveter, when desired, the necessary over-head rigging of a crane, consisting of sheaves mounted in a carriage, with machinery for drawing the carriage back and forth on rails placed on beams over-head, and for hoisting purposes. Crane attach-  
ment.  
We furnish a patent safety-crab, which, bolted to the foundation back of the machine, is operated either by hand or power, and is entirely under the control of the man who handles the valve of the riveter. The position and condition of the over-head work depend entirely on the character of the work done. When cylindrical work only is riveted, the ways upon which the over-head carriage rests may be in line with the axis of the riveting machine. If much straight-plate work is riveted, the ways should be placed crossways, or at right angles to the axis of machine, and a lateral  
Safety-crab.

Will do all  
kinds of boiler  
riveting.

Large  
machine.

motion should be given to the ways to adjust them in proper position in reference to centre of gravity of work being riveted and the position of the riveting stake. The riveting machine, as ordinarily constructed by us, is intended for locomotive work especially ; but can as well do all the work on plain cylinder boilers, or on marine boilers. In addition to our regular size, we make a larger one, with a capacity to take in sheets 6 feet wide, with special reference to use in making wagon-top boilers. We also adapt, when required, a supplementary riveting stake of steel, upon which flues 10 inches diameter, and in length of 3 feet rings, may be riveted.







## HYDROSTATIC WHEEL PRESS,

Of capacity for putting two 6-foot driving wheels upon the axle at the same time; maximum power 150 tons. Cylinder lined with copper in an improved manner. Double acting brass pump arranged with pressure gauge and stop valve, and improved safety valve to prevent overloading. Chain slings and elevating screws for wheels and axles traveling on top rail of press. The resistance beam or post is suspended from wheels on top rail and movable to any position, thus acting equally well for pulling off and pushing on. Wrought iron work case hardened. Over-head shaft, with ball and socket hangers and fast and loose pulleys 36 inches diameter, 7 inches face, which should make 100 revolutions per minute.

Same machine of capacity for 36-inch wheels.

THESE machines, both the one for driving wheels, which takes in a 72-inch wheel, and the one for car wheels, which takes in 36-inch wheels, have a power of 150 tons. This power is not expected to be used to its full extent in pushing on wheels, but in pulling off those that have become rusted fast. In practice, it has been found that car axles made cylindrical (not conical) in the "fit," if made .007 inches larger than the hole in the wheel, require 30 tons to force on, and will never come loose in use. The value of the hydrostatic wheel press over any form of screw press is in the possibility of always noting the pressing force used. On some of the screw presses made it has been found necessary to adapt a hydrostatic cylinder and pressure gauge to resist the force of the screw, and thus indicate the pressure used. This led to the use of hydrostatic forcing machines exclusively, and the present machine is the result of many years' experience with

Force required  
for car-wheel.

Iron cylinder  
not lined will  
break.

this way of forcing on wheels, and which experience indicated a rather short durability to the early machines, not lined with copper.

Method of  
lining.

Those which we make are provided with copper-lined cylinders made without any break in the continuity of the lining, insuring durability. This method of making the cylinders is of great importance.

Safety valve.

The safety valve, which is inaccessible to the workman, will not permit a greater pressure than 5000 pounds to the square inch being obtained, and its spring is at all times relaxed except during the time of the press being in action, thus giving it ample time for rest and insuring its constant accuracy. The pump is of the best bronze, and is double acting.

Use oil.

Fluid used is oil, and when the pump wheel runs 100 revolutions per minute the motion of the ram is seemingly constant. This is important, as with single acting pumps the wheel goes on with jerks. Fast and loose pulleys on the counter-shaft are 36 inches diameter for 7 inches belt, and should make 100 revolutions per minute.

Speed.

Position in  
shop.

This machine stands at right angles to the line of shaft, but if the arrangement of the shop require its being placed parallel with the line, the power may be conveniently carried to it over a set of mule pulleys.

## RAILWAY TRANSFER TABLES.

THE most convenient form of building for locomotive and car shop, seems to be that in which independent stalls are arranged in line side by side. This calls for some convenient form of transfer or sliding table to shift engines or cars bodily sideways. We have, to meet this want, designed a wrought iron transfer table, formed of I beams riveted together, upon which the rails are laid. The structure is carried on four or six pairs of 36-inch wheels, resting on two or three tracks laid lengthways of the pit; the tracks being 6 feet gauge. The pit is lined at bottom, and very shallow, being only  $11\frac{1}{2}$  inches from base of rail on road,—i.e. from top of table to top of rails in pit; and as the pit may be paved level with the top of rails in it, the pit is practically but  $11\frac{1}{2}$  inches deep, and offers no impediment to those wishing to cross it. The frame of this table is well adapted for the reception of a vertical boiler and engine to move the table by power, and where much work is to be done this is economical.

We also make a cast iron table twenty-eight feet long, requiring a deeper pit, but arranged with gearing to move the table by hand.

## RAILWAY TURNING TABLES.

## DIMENSIONS OF TABLES.

	6' Table.	56' Table.	54' Table.	50' Ex. heavy. Table.	50' Table.	45' Table.	40' Table.	30' Table.	12' Table.	9' 4" Table.	9' 4" Table.
Diameter of Pit . . . . .	60' 1"	56' 1"	54' 1"	5' 1"	50' 1"	45' 1"	40' 3"	30' 4"	12'		
Diameter of Circular Track.	56'	52'	50' 2 1/4"	45' 10"	45' 10"	41' 4"	36' 5"	27'	10' 6"		
Distance from under side of rail on Table to top of Table Casting . . . . .	5"	5"	5"	5"	5"	5"	5"	5"	5"		
Distance from top of Table Casting to top of Centre Stone . . . . .	4' 1"	4' 1"	4' 1"	3' 10 3/4"	3' 7 3/4"	3' 7 3/4"	3' 13 3/4"	2' 5"	2' 5"		
Size of Centre Stone . . . . .	6' sq. by 15"	6' sq. by 15"	6' sq. by 15"	5' 6" sq. by 15"	5' 6" sq. by 15"	5' 6" sq. by 15"	5' sq. by 12"	5' sq. by 10"	5' sq. by 10"		
Height of rail on Table, when level, above rail on road . . . . .	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	3/8"	1/4"	1/4"		
Height from under side of rail on road to top of Centre Stone . . . . .	4' 5 1/2"	4' 5 1/2"	4' 5 1/2"	4' 3 1/4"	4' 0 1/4"	4' 0 1/4"	3' 6 3/8"	2' 9 3/4"	2' 9 3/4"		
Height from under side of rail on road to top of Circular Track . . . . .	1' 9 1/2"	1' 9 1/2"	1' 9 1/2"	1' 8 1/2"	1' 8 1/2"	1' 8"	1' 8 3/8"	1' 8 1/4"	1' 10 1/2"		

For City Passenger Cars  
no Pit required.For heavy Freight Cars  
no Pit required.

## RAILWAY TURNING TABLES.

SINCE our introduction of cast iron turn-tables for railroads, we have made many hundreds of them, of all sizes, and their use has extended over the greater part of both continents of America. They are simple in form, very durable, and easily put in place, requiring comparatively inexpensive pits, and turn with ease. The table proper consists of four cast iron arms or beams, of proper shape for strength, firmly bolted, and secured to a cast iron centre box of requisite width. In the centre of this box is placed the peculiar pivot upon which the table turns. At outer ends of the arms are cross girts carrying wheels to swing clear of a circular track rail, and upon which rail these wheels rest when the table tips, but they swing clear of it in turning.

Arms.

Centre box.

Cross girts.

In the centre of the pit is placed a conical centre post, with a broad base resting on a firm foundation of stone. This post extends nearly to the top of the centre box. The top of post is made hemispherical, and in it rests a cast iron cap, carrying a set of steel plates grooved and filled with conical steel rollers. The whole weight of table and engine rests on these steel rolls in turning. A cap of cast iron rests on the top steel plate, and to this cap the centre box is suspended on a circle of bolts, with a layer of wood between the box and cap. By taking out this wood and thinning it or adding more to it, the table can be adjusted in height. Upon the arms cross ties are laid,

Post.

Steel plates and rolls.

Layers of wood for adjustment.

Centre foundation.	and to these ties the rail similar to that on the road is secured. The pit is usually built with a curbing of stone, and in the centre must be built a strong foundation of a size suitable to carry a top stone of the size prescribed in our list of dimensions. The
Form of pit.	pit is deepest in the centre, and grows shallower towards the circumference, ending in a level plateau for the reception of the circular track. This track
Circular track must be level.	should be carefully leveled, and should rest on well-laid sills,—stone or iron preferable to wooden sills.
Gearred table.	We have made gearing for turning these tables, but its application is worse than useless. One man, with a lever of such a length as will extend over the curbing of the pit, can, with ease, turn the heaviest engine.
Power required to turn.	The power required to turn a table 50 feet in diameter, weighing over 24,000 pounds, was tried in our works, and it was found that one and one-half pounds pressure, applied at one end of the arms, was sufficient to start its motion from a state of rest. We make
Covered pit.	provision for adapting a cover to the entire pit, but it somewhat impedes the ease of turning; and in most cases the covered pit has been abandoned, even in round-houses, and the pit left open. The distance from top of curbing to circular track is so little—
Depth of pit	about twenty inches—that the pit may be crossed by stepping down into it, if necessary. It may be noted, also, that as the steel plates and rolls upon which the table turns are near to the top of the table, the pit
Water in pit.	may be almost filled with water without interfering with the motions of the table, other than the resistance offered by the water. The introduction of steel
Steel in place of cast iron for plates and rolls.	centre plates and steel rolls in place of cast iron ones, as was our early practice, has made them very much more durable, and increased the ease of turning. At-

tention being paid to these rolls, they are practically indestructible. They should be occasionally cleaned, —once every three months, at least,—and at all times kept well oiled. Oil mixed with tallow, so as to be soft in cold weather, will answer a good purpose. In case of the breakage of any part by accident, such as an engine being run into pit with the table out of place, etc., the broken parts can be readily replaced with new ones, as all the pieces are planed to gauge and are interchangeable; but if arms are broken, we should be advised if the broken one has key-ways at the large end where the T bolt fits into the recess in arm.

Must be kept clean and oiled.

Ease of repair.

Send description of broken parts.

In regard to diameter of table to suit any particular case, the larger diameters are the best, as the engine, either with empty or with full tender, can be most readily balanced; and it is necessary that the centre of gravity of the load be in all cases brought over the centre of the table, so as to have no appreciable weight on the circular track. When these tables were first made, 40 or 45 feet in diameter seemed to meet the case of the engines then in use; afterwards the increase of weight of rolling-stock compelled the introduction of 50 feet; still later of 54 feet, 56 feet, and 60 feet lengths. The 50 feet table having been placed in many round-houses and other positions where the larger sizes could not be conveniently used, the increase of weight of engines called for an extra heavy 50 feet table. This is designed to fill the want in such cases as the above, and is adapted to the heaviest engines that can be turned in such a diameter of pit; while the regular 50 feet table answers a good purpose for roads having engines of 25 or 30 tons weight only. The gauge of road has

Diameter of table.

40 and 45 feet tables.

50 and 60 feet tables.

Extra heavy 50 feet table.

Gauge of road.

	nothing to do with the width of table: hence we sell the same table for 3 feet and 3 feet 6 inches gauge as we do for the 4 feet 8½ inches and 5 feet gauge.
For 6 feet gauge.	For 6 feet gauge we recommend our 54 feet size and over, as being wider in the centre box. The table
30 feet table for cars.	30 feet in diameter is intended for use in freight-depots for turning cars; has been used on coal-roads for turning at "tips," and in one or two cases has been made with platform-scale attached, to permit weighing on the cars and load while on the table.
Tables for shop use.	We also make smaller sizes for shop use and for street passenger railways. The former of these is 9 feet 4 inches diameter, and is heavy enough to permit loads as great as can be readily got on that diameter being turned. The pit is shallow, and the table covers the entire opening. The latter table, for
Shallow pit.	street roads, is lighter, can be readily put in place in the street, and offers no obstruction to the ordinary travel of carriages, etc. It is provided with a lock
For street passenger roads.	that is operated by keys in the hands of the drivers, and which cannot be tampered with by others using the street. This was called for to prevent boys from playing with the tables. The use of these small tables has extended to all our principal cities. Our remarks upon care of the steel rolls apply to these tables, which turn in cast iron conical rollers.
Mode of locking.	
Locking gear.	We make to all sizes of tables an improved locking gear, when ordered; but in the majority of cases the purchaser arranges his own mode of locking them.



## CENTRAL SUSPENDED TURN-TABLE FOR SWING BRIDGES.

PATENTED { August 2, 1853. } EXT'D July 15, 1867.  
May 14, 1867. }

We would request the attention of bridge-builders, engineers, and others to our Improved Central Suspended Turn-tables for Swing Bridges.

*This system secures economy in construction, great durability, and admits of a high speed of operation at a comparatively small expenditure of power.*

### DESCRIPTION OF CENTRAL SUSPENDED TURN-TABLE.

The bridge is carried immediately by a double-webbed circular compound girder or drum, on which the weight of the bridge is evenly distributed, that is, carried at eight points equally divided in its circumference. The drum and its load are suspended from the centre pivot by a system of radial diagonal ties or bolts, so that the whole weight rests on the centre bearing, and is there carried by one or two series of cast steel rollers, of such number and so proportioned that the pressure against the friction surface is always within the limits of possible lubrication.

The large circle of wheels underneath the drum is used solely to steady the bridge when swinging, and it is not contemplated that any part of the actual weight of the bridge shall be carried on these wheels.

The swinging gear consists of one or two sets of pinions and shafts, having their bearings on the drum, and acting on a fixed circular rack, bolted to the wheel track. This swinging gear can be arranged to be operated by hand, steam, or other power.

THE ease with which locomotives can be turned on our improved cast iron turn-table for railway purposes, early led to the inquiry for the application of the same principle to tables of swing or pivot bridges. The success of this principle depends upon the entire weight of the superstructure being carried on the centre, and resting on the steel conical rollers placed there to receive it. With tables as ordinarily made this was not readily done. Hence, in practice, much of the weight of the bridge is carried on rollers placed on a circular track near to the outside

Entire weight  
on centre.

Applicable to all forms of superstructure.	of centre pier. Our central suspended turn-table was designed to meet this want, and is applicable to all forms of swing bridges. We so arrange the structure as to insure the entire weight being carried on the centre plates, and we use the track rollers only to take the tip of the table. These track rollers we make the same for all weights of table, using more or less of them in the circle as the case requires, but never expecting that any of the load shall rest upon them. We provide a drum of wrought iron with top and bottom ends of cast iron, like a compound beam in structure; this drum is suspended from a centre box by means of diagonal tie rods and struts in alternation with counter rods from top of drum to base of centre box. Upon this outer drum the chords of bridge rest in such a way as to cause the load to fall in eight equidistant points on its circumference, thus insuring an equal distribution of the load. The
Track rollers to prevent tip.	rollers for circular track are carried in a wrought iron spider frame, and rest on cast iron segments placed in the stone work of the centre pier; to these segments are secured the toothed segments into which the pinions gear that do the turning.
Circular.	
Tie rods and struts.	
Weight carried on eight points.	
Track rollers.	
Gear segments.	

Steam machinery for turning.

Power required.

For bridges of 300 tons and under, the turning is always done by hand, but to larger sizes we have sometimes adapted steam turning machinery; in which case we so arrange the steam power in the centre drum or on the outside of it as the case may require, and all the motions of unlocking and loosening the ends of draw as well as turning are done at centre, and are effected by power, in either direction and at variable velocities. When turning by hand, two men can with ease turn a bridge of 260 tons weight. The chief engineer of the P. F. W. & C. R. R. reported

that a table of our construction, on the South Fork of the Chicago River, with a bridge of 260 tons weight, was used during seven months of the year 1868, as follows :

Number of vessels passed.....	43,735
" " times swung .....	16,984
Travel of ends of bridge.....	1,077 miles.
" " of men in turning.....	1,517 "

This table has required no repairs, can be opened and closed by two men in 45 sec. each way. When asked for bids on these tables, we should know—

1. Weight of bridge, resting on table.
2. Distance from centre to centre of chords.
3. Whether two or three chords.
4. Nature of bottom chord (width and general character).
5. Available height for table, between high water and the under side of chord.
6. Distance from under side of chord to under side of rail in road, or to under side of roadway (should be about 8 feet, if possible).
7. If to turn by hand or steam power.

Dimensions required.

As a general thing, we furnish only the centre casting, containing the steel plates and rolls, the centre post, the spider frame and track rollers, and the track with gearing bolted to the centre pin, as also the pinions, and their shafts and bearings, used in turning the bridge; the bridge-builders making the circular drum to drawings, which we furnish, and making also the system of struts and diagonal tie rods between the centre casting and the drum. But we will bid on the entire table if so desired.

Parts furnished.

Drawings furnished.

## SHAFTING.

We furnish, upon application, a price list, in which we call attention to the following mechanical advantages of our system, we having made the construction of Shafting a *specialty*:

1. All sizes are made to standard gauges.
2. The *Double Cone Vice Coupling* admits of quick and very easy attachment and detachment.
3. The *Double Braced Ball and Socket* hangers are light but very strong, and readily adjustable in every direction.
4. *Long Journal Bearings* held so as to always insure a uniform distribution of pressure over the entire length of bearing.
5. The appropriate distribution of metal in Pulley Castings, giving the greatest strength with the least quantity of material.

The introduction of a scale of fixed prices for every separate article, enables the consumer to know in advance the *exact sum* his work will cost, thus giving a great advantage over the purchase by the *pound*, the amount of which is generally indefinite. Purchasers of our Improved Shafting will make not only a direct saving in first cost, but a continual one, by the acquisition of a well-constructed and easy-running system for the transmission of power, very neat in appearance, and as light as is consistent with the requisite strength; our extended experience having enabled us to establish correct proportions without any undue expenditure of material.

HAVING been engaged since the year 1848 in the manufacture of shafting and mill gearing, during which time we have introduced a

Fixed scale of prices.

fixed scale of prices for the various articles comprised under the name of "Shafting," we have from time to time made important improvements, and, by the introduction of special tools, been enabled to very much reduce the cost of the articles needed in this line.

Shafting considered as a machine.

In any large factory the shafting, with its couplings, pulleys, and other adjuncts, considered as a machine to transmit motion, is most frequently the largest in the establishment: hence every consideration of economy

requires that it should do its allotted work with the least possible loss of power in the transmission. It calls for economy in first cost, and economy in use.

The generation of power to be expended in operating machines to do work costs something; it may cost much money in fuel consumed, or it may cost something in energy expended. In any case, the more perfectly the whole power is transmitted to the work, the more profitable will be its use.

It is a noteworthy historical fact, that economy in the generation of power in the motor, and economy in the utilization of the power in the machine, have been in most countries far in advance of the economical transmission of power from one to the other. Years ago there were excellent models of water-wheels, and by them were driven machines of surprising ingenuity, but the power was conveyed by means of cumbersome wooden shafts upon which were wooden drums for the driving belts; gearing too, made of wood, slow-moving, awkward contrivances for the purpose, and very wasteful of power.

History of improvements.

In the progress of the art, it is quite evident that early engineers in iron took their ideas from what had been done in wood. They copied in iron what had been the practice in wood. Cumbersome, slow-moving iron shafts took the place of slow-moving wooden shafts. Gear wheels were used to transmit the power from the motor to the shafts, and from shaft to shaft in the various rooms and situations requiring power; while belts or bands from pulleys were only used to transmit the power from the shafts to the individual machines. The practice of high-speeded shafts, and the entire substitution of belting for gear wheels, belong essentially to this country.

Early engineers in iron took model from the practice with wood.

Belts vs. gear-wheels.

The value of high speed in belts has been long known in England and in some parts of Europe, and many wonderful examples there exist of its application. These examples are, however, exceptional, and have not come to be general mill practice.

Mr. R. Willis.

It may be well to note that in a book published in London in 1841,—“Principles of Mechanism,” by Robert Willis, M.A., F.R.S.,—mention is made of the use of belts, and what was the practice in America at that time, in these words:

“Belts, on account of their silent and quiet action, are very much employed for machinery in London, to avoid nuisance to neighbors. It appears, also, from a recent work,\* that the use of belts is greatly extended in American factories. In Great Britain the motion is conveyed from the first moving power to the different buildings and apartments of a factory by means of long shafts and toothed wheels, but in America by large belts, moving rapidly, of the breadth of 12 or 15 inches, according to the force they have to exert.”

What Prof. Willis says in regard to American practice has continued to be the practice since this was written, but has been vastly extended; here the employment of wider belts and faster-running shafts has become more general, while this extensive use of belting obtains in very few cases abroad, even up to the present time.

Use of gear wheels limits the speed.

The use of gear wheels to transmit the motion from one shaft to another limits the speed at which the shafts may be run. Too high a speed causes the teeth to break even when doing no work,—*i.e.* when the load

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\* Cotton Manufacture of America, by J. Montgomery, 1840, p. 19.

is off. With belt-driven shafts any convenient speed may be obtained, and thus the smallest possible size of pulleys on the line be used. To obtain the high speed found advantageous in modern mill practice, the shafts must be straight and truly cylindrical; they must be united by couplings that hold them firmly, and be provided with bearings that will maintain the shaft in a true line, so as with proper lubrication to reduce the friction to a minimum. Since the introduction of turned iron shafts, a great many contrivances have been used to unite shafts. It must be borne in mind that the coupling should be of such a nature that the strength and rigidity at the joint shall be as great, if not greater, than in any part of the line, so that if the line be subjected to flexure, it will bend anywhere else than in the coupling. In England, up to the present time, it is considered good practice to make the ends of all shafts larger than the body of the shaft by forging, and then to these enlarged parts secure the couplings by various and sometimes expensive means. Shafts so enlarged at the ends cannot be made to receive carefully bored pulleys, unless the pulleys be made in halves, bolted together upon the shaft. Shafts come from the rolling mill, of certain merchantable sizes, as round iron. These round bars, when turned so as to be of uniform diameter, should be united without the extra cost of enlarging the ends.

With belts high speeds are possible.

Requirements of a good coupling.

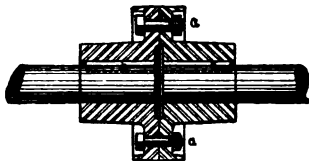
English practice as regards couplings.

The first really good coupling used for this purpose was what is known as the plate coupling. This coupling (Fig. 5) consists of two plates, with stout hubs, fitted with great care to the ends of the shafts to be coupled, and the plates then held together by very carefully fitted bolts, *a a*, which are turned and fitted

Plate coupling.

into reamed holes. There are also keys (*b*) provided to prevent the couplings turning on the shafts. This,

FIG. 5.



when well made, is an excellent form of coupling, but it has manifest disadvantages; its first cost need not be very great, but it requires too much care in fitting.

We have said that keys are used to prevent its turning. They must be put in as a precaution, not as an actual necessity, and must be made to fit on their sides, not on their top or bottom. (See Fig. 6.)

Use of keys in plate coupling.

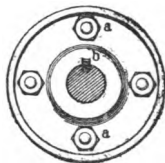
How plate couplings are fitted.

Key.

The effect of taper keys.

The coupling is usually bored to some standard size, say  $\frac{1}{16}$  of an inch less in diameter than the body of the finished shaft. The ends of the shaft are turned, in the case of a 4-inch shaft, .015 of an inch larger than the hole in the coupling; key seats are cut in the shaft and in the coupling, and a parallel key fitting sideways, not top and bottom, is laid in the keyway in shaft, and the coupling forced on by a powerful press with say from 20 to 30 tons pressure.

FIG. 6.

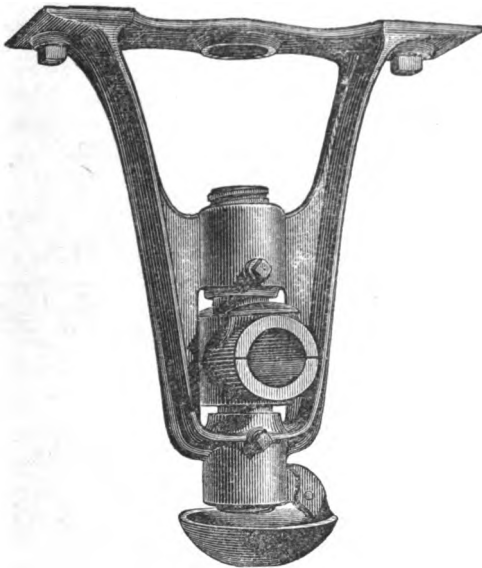


If a plate coupling be so fitted as to slide on and off easily, and an attempt be made to hold it in place by a taper key, fitting top and bottom, the pressure on the shaft will be on two opposite lines only, and



sooner or later such coupling will work loose. To drive in a taper key is the very surest way to break or burst the surrounding metal, or at least make it run out of true. We cannot too strongly condemn the use of taper keys in all similar cases. A plate coupling, when properly fitted, requires great force to remove it, when its removal is needed for the placement of pulleys on the line, and frequent removal in-

FIG. 7.



duces its fit. It also necessitates the use of open-sided or hook hangers, as the coupling cannot be put on after the shaft is in place. These hangers, for equal strength, require double the metal used in a hanger with metal on both sides of the box. (See Fig. 7.) The greatest objection, however, to the use

Obliges use of  
open-sided  
hanger.

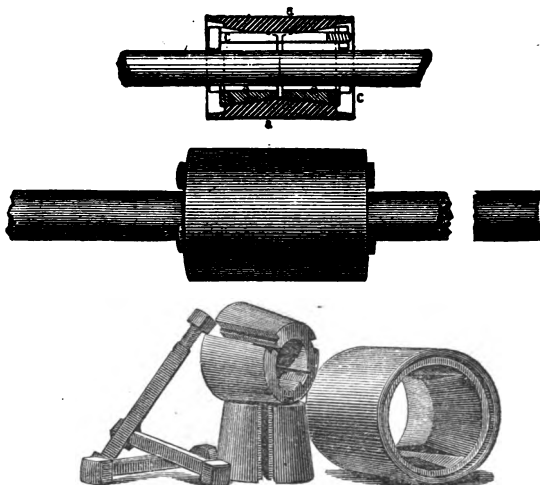
No inspection  
will insure  
perfect fits.

of this and similar kinds of coupling is in the fact that skilled labor is required to insure accurate fits, and that no practicable system of inspection will enable the mill owner to know that the fits are good ones. The working out of any shaft from its coupling may result in the fall of the section of shaft, the breaking of valuable machinery, or, too often, the loss of life.

1856.

Previous to the year 1856 we used the plate coupling exclusively, with a hanger made open on one side. Desirous of insuring accuracy of fit of coupling

FIG. 8.



Patent  
coupling.

independent of the skill of workmen, we, during that year, introduced a coupling which, while it fills all the requirements of absolute security, can be cheaply made, and admits of ready removal and ready adjustment when pulleys, etc., are to be added or changed.

This coupling (Fig. 8), which we have called the double cone vice coupling, consists of three principal parts,—an outer sleeve, *a*, and two inner sleeves, *b b*. The outer sleeve has its interior surface made like two frustums of cones, with the apex of each meeting in the centre of the sleeve. *b b* are conical sleeves, bored to fit on the shafts intended to be coupled, and having their outer surfaces so turned as to fit into the conical holes of the outer sleeve, *a*. The cones *b b* have three equidistant square slots cut in them, and there are corresponding slots on the inside of the outer sleeve. These slots are to receive square bolts, *c c c*. The sleeves *b b*, when put into place in the outer sleeve, will not quite meet,—*i.e.* they are too large to go in all the way. They are, however, split, each one, in one of the square slots at *d*. This split makes them elastic, and if they be forced into the conical holes they will contract, and thus diminish the size of the centre holes. The square bolts, *c c c*, while they serve as keys to prevent the inner sleeves from turning, also serve as a means of drawing the conical sleeves towards one another; so that if the ends of shafts be in these sleeves, such ends will be pinched or held fast by the pressure, and that in proportion to the force used in screwing up the bolts.

An important feature to be noted is, that one cone cannot be drawn in with any more force than the other one; the resistance is the pressure on the shaft ends. The pressure on both ends of shafts in such a coupling must be equal, and is under the control of the person using and applying the coupling. The shafts need not be of exactly the same size; shafts of an appreciable difference in size may be as firmly held as if they were of the same diameter. Key slots are

Outer sleeve.

Inner sleeves.

Bolts.

Equalizes the pressure on each end.

provided as a precautionary matter, as shown at *ee*; but the keys must, as we have before stated, fit sideways, and not touch top or bottom. That the shafts united by this coupling need not be of the same diameter is a very important consideration, and leads us to dwell for a moment on an important feature of shafting, viz., its *cost*. Machines can readily be constructed to turn bars of round iron in the condition they come from the rolling mill to a nearly uniform size, with great rapidity and at a very small cost. The expression, *nearly uniform*, we use advisedly. We mean that shafts can be turned so that a standard hardened gauge can slide over them and seemingly they will be of uniform diameter; but a careful measurement would show them to be only approximately alike in size. They are what may be called commercially accurate. This commercial accuracy represents a certain cost of production. Absolute accuracy, were such a thing possible, would represent a cost many times greater. Commercial accuracy is attainable by machines and by unskilled labor; absolute accuracy would involve more costly processes and the utmost skill of the most experienced workmen. When the plate coupling was in common use, the bodies of the shafts were made of one size, and the coupling ends reduced by skilled workmen to a smaller size and carefully fitted to the coupling. It was this fitting that was costly. With the cone coupling this fitting is dispensed with, and shafts are sold as they come from the turning machines. An adjustable coupling, to be good for anything, must clamp each end uniformly.

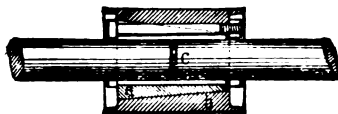
Commercial  
accuracy.

There are, and have been for years, many forms of adjustable couplings in use which do not fill this

requirement. As an example, one shown in Fig. 9, in which one long conical sleeve, *a*, fits in a conical hole

Single cone coupling.

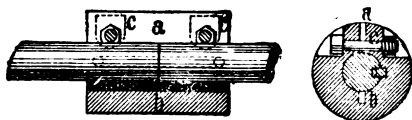
FIG. 9.



in the outer sleeve, *b*, and the shafts to be coupled meet in the centre, at *c*. The cone (*a*) being split as are the cones in the coupling before described, the conical sleeve, when forced in, will be compressed upon the two ends of the shafts, provided these ends are of exactly the same diameter; but if one is ever so little larger than the other end it will be held, and the smaller end will be loose, and, what is more, no amount of pressure exerted by the bolts will make such a coupling hold the smaller one as firmly as the larger end. So, again, a coupling made as shown in Fig. 10, which represents a plain cylindrical sleeve,

Require ends of shafts to be of uniform size.

FIG. 10.



split through at *a* and partly through at *b*, so as to render it elastic, and is compressed by bolts *c*,—such a coupling will hold shafts of exactly the same size, but will produce an unequal pressure on shafts of slightly different diameters. In practice, this latter coupling is made to hold by means of a peculiar key,

Sleeve coupling.

which extends over the two ends of the shafts to be united, and is provided with pins at its end, fitted into holes drilled in each shaft.

How to remove  
patent coupling.

While on the subject of adjustable couplings, it may be well to remark that in putting them on the shafts they should be put on with a view to removal. All parts should be well and carefully oiled, so as to avoid all chances of their rusting fast. And in event of required removal it is best to slack up the bolts, and if not then loose, a few blows upon the outer shell with a billet of wood may start it loose. In case of the double cone coupling, a wedge, say a cold chisel, driven into the split in inner cone always loosens the cones and frees the coupling.

Test of the  
cone coupling.

When the double cone coupling was first made, it was subjected to severe trials to test its utility. The experiment was made by coupling two shafts, which were placed on three bearings 10 feet apart, the coupling being near to the middle one. The hangers were so placed as to bend the shaft  $1\frac{3}{4}$  inches out of line. These shafts so coupled were then made to revolve 250 revolutions per minute for many weeks during working hours, and yet the coupling did not loosen under this severe strain. Since that time they have been made by thousands, and are in use in all parts of our country.

Next to the proper means of uniting the shafts, come the devices to sustain the shafts and permit them to revolve freely on their axes.

Mr. E. Bancroft.

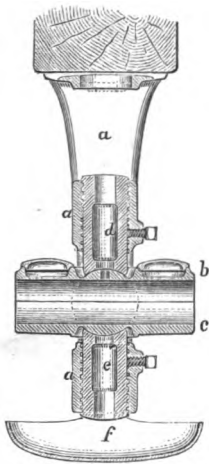
Swivel hanger.

About thirty years ago, Mr. Edward Bancroft, then engaged in the machine business in Providence, R. I., invented what was called the swivel hanger. In order to insure the weight of the shaft being received over the entire length of the box, he hung the box in a

kind of universal joint and made its axis of vibration coincide with the centre of the box. This permitted the use of longer boxes than were heretofore practicable, and the pressure per square inch on the surface was lessened. Before the introduction of the swivel hanger, rigid bearings were the only kind used,—we mean bearings which could not adjust themselves to the positions of the shafts,—and such rigid bearings are still used in Europe. When Mr. Bancroft had demonstrated the great advantages of the swivel or self-adjusting hanger bearing, he showed it to most of the prominent machine builders in the New England States, and tried to introduce it generally; but not one could be found who was willing to undertake its manu-

Rigid bear-  
ings.

FIG. 11.



facture. They characterized it as a needless piece of refinement, and far too costly to be generally used. Mr. Bancroft afterwards, in connection with Mr. William Sellers, under the firm name of Bancroft & Sellers, manufactured this hanger, and introduced it extensively.

This swivel hanger was afterwards superseded by what is called the ball and socket hanger, now in almost universal use in this country, which is the same in principle but differs in detail. Various circumstances have, from time to time, caused

Ball and socket  
hanger.

modification in the form of the supporting frame, but the principle has remained unchanged. Fig. 11 shows a section of the modern hanger. The part marked *a*

Frame of  
hanger.

Plungers.

Oil dish.

Trouble of set-  
ting rigid  
hangers.

Increase of  
cost to user.

is the frame or hanger; *b*, the top box, and *c*, the bottom box, the two halves united, forming what is called the "box,"—*i.e.* the journal box or bearing: the bearing in which the shaft rotates. This box is provided, top and bottom, with spherical surfaces, so placed as to be, in reality, portions of a sphere which has its centre in the centre of the axis of the box; *d* and *e* are what are called the plungers. These are screwed into the frame, and are provided with cup-shaped ends to clasp the spherical parts of the box. The box can rock to a limited extent in every direction in these cup-shaped ends. The plungers serve a double purpose: 1st, of providing the socket for the sphere to roll in; 2d, to permit of a vertical adjustment of the entire box to bring them in line one with another; *f* is an oil dish to catch the drippings from the box. It is quite evident that a shaft placed in such a bearing will control the positions of the box, and will press uniformly over the entire length of the box.

This is a very important feature, as can be seen when compared with a rigid bearing. When hangers, having their boxes or bearings made in one piece with the hanger, are to be attached to beams, some distance from each other, they must be bolted securely to the beams in such positions as will insure all the boxes in the entire series being in line one with another, so that a shaft placed in the boxes will rotate freely without binding. It will readily be seen that to do this the foot of the hanger must be carefully fitted to the beam, so that a line stretched through the various boxes will touch all parts of each. This involves great skill and much time in putting up. This skill and time is at the cost of the purchaser and user of the hanger.



Then when they are in place, the warping or twisting or sinking down of any one beam will throw the bearing out of line, and thus tend to cramp the shaft in its bearings. With the ball and socket hanger, care is only required to bring the hangers in line side-ways; the plungers admit of adjustment vertically, and the shafts twist the box into line with itself. Thus all skilled labor is dispensed with in putting up, and possible adjustment is at all times practical.

Ease of putting  
up ball and  
socket hang-  
ers.

But the most important feature of this hanger is the possibility of using longer bearings or boxes than with the rigid hanger. With the latter, the longer the box the more difficult to line, and the more useless friction if out of line. With the swiveling principle, the box adjusts itself, and thus takes a uniform bearing over its entire length. This is of the greatest importance, and influences the material forming the box. With a pressure not exceeding fifty pounds per square inch, and oil well distributed over the surface of the box, the metal of the shaft will not touch the surface of the box; it will run on the oil used as a lubricator. The oil under this pressure is not squeezed out, and maintains its lubricating properties for a long time. Hence, if the shaft does not touch the box, it matters little what metal is used in making the box. Cast iron is the cheapest and most readily worked into shape. It is, in reality, the most durable of the metals for the purpose if kept well oiled, but the poorest if allowed to run dry. Brass or bronze has been used to a great extent, and lately a metal called Babbitt's metal has met with favor as a lining metal for boxes; but we may mention that a cast iron nut on a lead screw of a lathe will outwear a brass nut two to one, and cast iron gear wheels are

Pressure on  
the bearing.

Oil is not  
squeezed out.

Babbitt's  
metal.

much more durable than brass under limited pressure ; that is, if the pressure on two pairs of wheels, one pair iron and one pair brass, be the same, and the pressure on both be within the limit at which cast iron will run without breaking, the cast iron wheels will last much the longest. Brass is resorted to for greater toughness, not for durability. The soft metals, under the general term of Babbitt's metal, are cast into recesses in journal bearings, and are extensively used. There are places where its use is advantageous, but for shafting purposes its use is to be discouraged. All soft metals, while they do not cut when permitted to run dry, in the way cast iron is sure to do, yet they serve to catch the grit and dirt in the atmosphere which finds its way in with the oil, and the soft metal holds these little sharp particles, and thus gradually grinds down the shaft running in it. When it is desired to grind down a cylinder of hard metal, lead clamps are applied to its surface very like journal boxes, and into these clamps oil and emery is fed. The lead will hold the emery, and thus reduce the size of the hard metal without serious wear on its own part. It is claimed that boxes cast with a recess to hold the soft metal can be used as they come from the foundry, and thus all labor of boring and fitting be dispensed with ; the shaft can be laid in place on the cast iron shell, and soft metal, melted in a ladle, can be poured in, thus filling the recess and insuring a fit. This sounds very plausible ; but the box with its recess must be rather larger, to be of equal strength, with one cast without such recess. Babbitt's metal costs much more than cast iron ; we may safely say it costs ten times as much. The melting and pouring takes time, which costs money. Now, in point of

Soft metal linings hold grit.

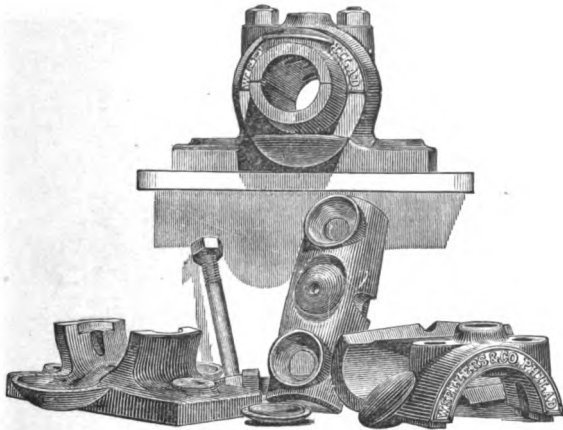
Comparison of cost of soft metal bearing.

fact, a pair of cast iron boxes can be planed on their faces, then bored to fit the shaft, and grooved for oil passages, for less than half of what the least quantity of soft metal would cost that can be used in such a box.

What we have said in description of the modern hanger holds good in the various forms of bearing, suited to various uses, where hangers are not admissible. Thus, when the shaft is to be carried by stone piers, not likely to lose their horizontal adjustment, or in case of vertical shaft, pillow blocks are used in place of hangers. (See Fig. 12.) The box is furnished

Pillow blocks.

FIG. 12.



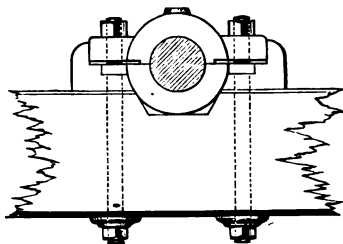
with spherical surfaces to fit in sockets in the casting or frame; it is self-adjusting as to line, but cannot be raised or lowered, as in the case of the hanger. It takes the place of what is known as the clamp box (see Fig. 13), and of any rigid bearing not adjustable.

Takes the  
place of clamp  
boxes.

Pillow blocks are sometimes used in connection

with cast iron wall plates upon which they rest, and are secured by bolts. (See Fig. 14.) This same com-

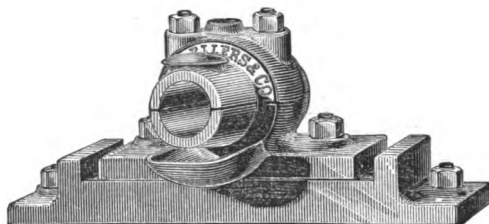
FIG. 13.



Use of pillow  
block on head  
shafts.

bination inverted, with an oil dish on the cap of the pillow block, is now used extensively to carry the head

FIG. 14.



Inverted pil-  
low block.

Arched wall  
box.

Brackets for  
pillow blocks.

shaft of long lines, as it admits of the very heavy head shaft, with large pulleys, being hoisted into place and then secured by the cap and bolts. Head shafts, or the first shaft of any line, usually rest in two bearings. Fig. 15 shows such an inverted pillow block. Sometimes it is requisite to build bearings in a wall, in which case what is called an arched wall box (Fig. 16) is used in connection with the pillow block. Very often it is advisable to support the line shaft from the face of a wall, in which case pillow blocks, secured to knees, are very convenient. (Fig. 17.)

FIG. 15.

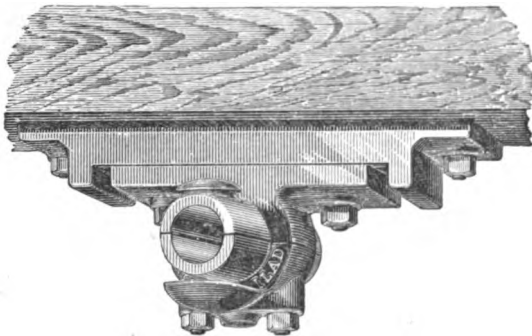


FIG. 16.

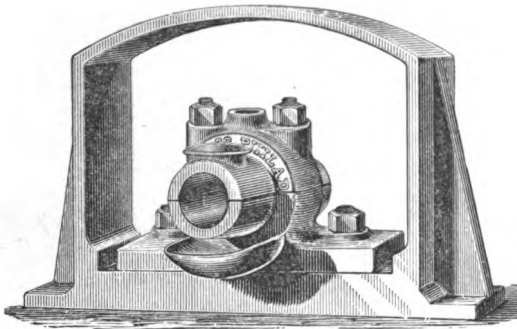
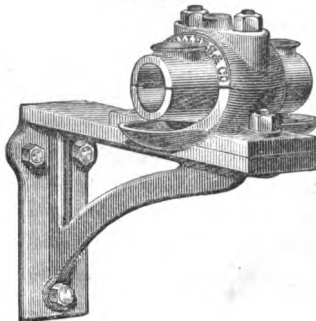


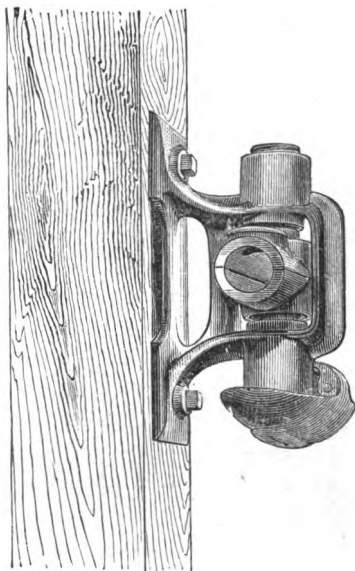
FIG. 17.



Post hanger.

Fig. 18 shows an example of a hanger to be fitted to a post; it is called in that form a post hanger. It is, in all essential particulars, like the ordinary hanger, so far as its adjustment and swiveling principles are concerned.

FIG. 18.



Durability of  
cast iron bear-  
ings.

As an illustration of the durability of cast iron bearings for shafting purposes, we may mention that some time since we took occasion to examine a bearing in which had been running, for sixteen years, a  $4\frac{1}{2}$ -inch shaft, with a pulley 72 inches diameter and 20 inches face, close to the bearing, taking all the power from an engine of 16-inch cylinder, 3-foot stroke, making 50 strokes per minute,—say transmitting fifty-two horse-

power. This bearing showed a bright surface over the extent of one-third of the circumference of the shaft on the bottom half box. The box had been originally made to fit the journal loosely, and it had not worn enough to make it fit over one-third of the circumference of the shaft. In the use of cast iron bearings, lubrication must be attended to, else the bearing will soon be cut and rendered useless; but lubrication is so easy, and so little oil is needed for the purpose, that there can be no reasonable excuse for neglect. We provide every box with large cavities in each end of the top box; these cavities are called tallow cups. They should be filled with tallow and oil, mixed so as to be of such a consistency as not to be fluid in warm weather. Should the journal heat from any cause, this same solid lubricant will melt, and, running into the bearing, will protect it for the time being. The box should be oiled in the centre; and oil holes are provided for that purpose in the recess around the spherical portion of the top box. There is also a hole in the very centre of the ball on top, and the top plungers, which rest on the ball, being hollow, a self-feeding oil cup can be placed on top, and thus deliver oil regularly to the bearing. As to the quantity of the oil needed, we would remark that shafts running in self-adjusting hangers, with bearings four diameters long, at a speed of 120 revolutions per minute, require, on an average,  $2\frac{2}{10}$  fluidounces of oil per bearing for six months' oiling; and self-feeding oilers, placed on top, should not deliver any more than this quantity.

Lubrication.

Tallow cups.

Quantity of oil required.

From time to time a great deal is said about self-oiling boxes. By this term are meant boxes that are made to contain oil in some reservoir, usually under

Self-oiling boxes.

the shaft, and from which reservoir oil is fed to the shaft, and then allowed to run back into the reservoir and thus be used over and over again. It is said that bearings in self-oiling boxes have been made to run for a year or more without attention ; but we have never known a self-oiling box to be made to work well with so little oil as  $4\frac{4}{10}$  fluidounces in it. Some of them hold a pint each. One pint is 16 fluidounces, quite enough oil to last four years, if properly applied ; and yet it would never do to trust that quantity of oil for that time, as it would become deteriorated by age. Self-oiling boxes are rather more costly, and take more oil to run them, than properly made bearings oiled by hand. Self-oiling boxes are good things to sell,—better than to use ; they are good things to talk about to those who do not know what true economy in oiling is. Glass oil cups above the bearing, feeding oil at such a rate as to consume  $2\frac{1}{2}$  fluidounces in six months, to say hangers for  $2\frac{1}{2}$  shafts, are the best, and oil fed at this rate will not run out of the box ends, but will just supply the waste from consumption.

Glass oil cups.

All shafts, long or short, must be provided with some means of preventing end motion. Line shafts should have one pair of collars fitted to one of the bearings only. We recommend them to be placed on the head shaft,—that is, on the largest shaft which receives the power,—and thus control the position of the entire line ; more collars are apt to cause needless friction. When shafts are collared, the collars should be fast to the shaft ; loose collars held in place by set screws are sometimes used, but are more expensive and cumbersome than the fixed or fast collars. Some engineers prefer necking in the head shaft to some smaller size in the journals. Suppose the first or head shaft re-

Collars.

Loose collars.



quires to be made of iron  $6\frac{1}{2}$  inches diameter, to sustain the driving belt. This shaft might be necked in, and be carried by bearings say  $5\frac{1}{2}$  inches diameter, and the ends still further reduced to the size of the shaft to be coupled to it. This practice of necking in the bearings of the head shaft is common in modern cotton-mill practice, and has the advantage of diminishing the velocity of the surface motion and of the shaft in the box; for by diminishing the diameter we diminish the speed of the rubbing parts, and the tendency to heat is much increased with increase of velocity.

Necking in of shafts.

To determine the size of shafts for the transmission of a given power, a safe formula is  $D = \sqrt[3]{\frac{P}{R} \times 125}$ , Formula for size of shaft.

D being diameter of shaft, P the horse-power, and R the number of revolutions per minute. This gives a shaft strong enough to resist flexure, if the bearings are not too far apart. The distance apart that the bearings should be placed is an important consideration. Modern millwrights differ slightly in opinion in this respect: some construct their mills with beams 9 feet 6 inches apart, and put one hanger under each of the beams; others say 8 feet apart gives a better result. We are clearly of opinion that with 8 feet distance, and shafting lighter in proportion, the best result is obtained. The tendency now is to increase rather than diminish the speed of line shafts; and good practice is to run shafts for machine-shop purpose at 120 Speeds. revolutions, for wood-working machinery at 250 revolutions, and for cotton and woolen mills at from 300 to 400 revolutions per minute. Hollow or pipe shafting has been made to run at 600 revolutions per minute very satisfactorily. This kind of shafting is, however, too costly to be generally introduced.

Distance apart of hangers.

Mr. James B. Francis, of Lowell, says that since the Mr. James B. Francis.

decrease of the water-power in that town, or rather the rapid increase of the factories, they have been obliged to economize their power, and they are doing so by using smaller shafts at higher velocities, and have even made extended lines only  $1\frac{1}{4}$  inch in diameter. They so arrange the mill as to secure a hanger close to each transmitting pulley. The torsion in long lines limits the smallness of the shaft used, and in all probability the best result will be found to be obtained in the use of not less than  $1\frac{3}{4}$ -inch diameter for the smallest line shafts in cotton mills.

There are now running in some factories lines of shafting 1000 feet long each. The power is generally applied to the shaft in the centre of the mill, and the line extended each way from this. The head shaft being, say 5 inches diameter, the shafts extending each way are made smaller in proportion to the rate of distribution, so that from 5 inches they often taper down to  $1\frac{1}{4}$ . In coupling shafts of different sizes it is customary to reduce the end of the larger one to the size of the smaller shaft, and then to use a coupling suited to the smaller size.

Coupling  
shafts of dif-  
ferent sizes.

FIG. 19.

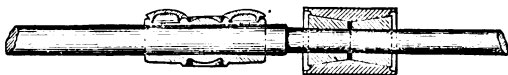


Fig. 19 shows an example of this method of reducing the larger shaft to the size of the smaller one. The rapidity with which the reduction of the size of the sections is made must depend, in all cases, on the distribution of the power. For instance, if a line of any length whatever receives its power at one end and transmits the same amount of power at its other end,

such shaft must be of uniform diameter ; but if it distributes its power at regular intervals along its length, the shaft may be made in sections of a size proportioned to the power given off.

When very long lines of shafting are constructed of small or comparatively small diameter, such lines are liable to some irregularities in speed, owing to the torsion or twisting of the shaft as power is taken from it in more or less irregular manner. Shafts driving looms may at one time be under the strain of driving all the looms belted from them, but as some looms are stopped the strain on the shaft becomes relaxed, and the torsional strain drives some part of the line ahead, and again retards it when the looms are started up. This irregularity is in some cases a matter of serious consideration, as in the instance of driving weaving-machinery. The looms are provided with delicate stop motion, whereby the breaking of a thread knocks off the belt shifter and stops the loom. An irregular driving motion is apt to cause the looms to knock off, as it is called, and hence the stopping of one or more may cause others near to them to stop also. This may in a measure be arrested by providing fly-wheels at intervals on the line shaft, so heavy in their rim as to act as a constant retardant and storer of power, which power is given back upon any reaction on the shaft, and thus the strain is equalized. We mention this, as at the present time it is occupying the thoughts of prominent millwrights, and the relative advantage and disadvantage of light and heavy shafts is being discussed, and is influencing the practice of modern mill construction.

Disadvantage  
of too small  
shafts.

Fly-wheels on  
line.

In a system of transmission by belts only, it is of importance that both the belts and the pulleys, or

Transmission  
of motion by  
belts.

band wheels upon which they run, should be in the best possible condition.

Leather belts.

The best belts used are of leather, kept in good condition by the judicious use of oil. Belts of leather are made of single thickness of leather for some purposes, and of two or more thicknesses for the endurance of heavier strains. In general, main driving belts are made double thickness, and belts for transmission of power to machines, with some exceptions, are made single thickness. The terms double and single belts have come to be applied to leather bands in the trade,

India-rubber belts.

while india-rubber belts, now quite extensively used, and often to advantage, have their grades indicated by one-ply, two-ply, three-ply, etc., as indicating their thickness. It is of the utmost importance, for considerations of economy in running, as well as first cost, that pulleys should be made as light as is consistent with strength. Pulleys that are to sustain the weight of double belts must be made heavier and stronger than those that are to sustain the weight of single belts; and the use to which the pulley is to be applied must influence its proportions. In the early practice of making cast iron pulleys it was believed necessary that the arms should be made something like the letter *S* on the plane of the pulley. The idea was that they would be less likely to break from shrinking strains in the casting. It is quite

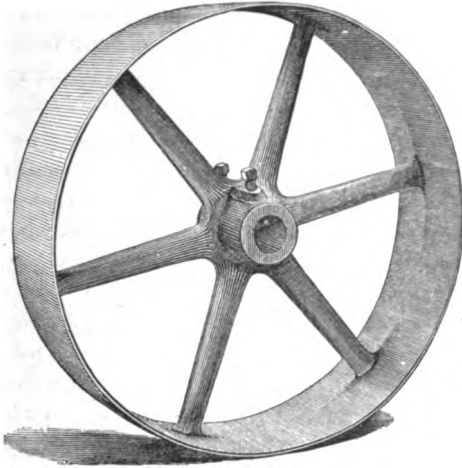
Pulleys for double belts.

Straight arm.

evident, however, that a straight arm, such as is shown in Fig. 20, representing a straight line from the centre to the circumference, will take the least metal; and we can state as a fact, after very long experience, that pulleys made with straight arms are the strongest, with equal proportions, provided proper precaution be taken in selecting the iron to be used in making and

regulating the conditions of cooling. The straight-armed pulley can be made with the least possible

FIG. 20.



metal and the greatest possible strength for the metal. Its form is the best able to transmit the peculiar strains brought to bear upon it, and at the same time it is the most pleasing form to the eye. In machinery, as in nature, fitness to intended purposes has much to do with our ideas of beauty.

We make the arms oval, of such proportion as to present the least surface of resistance to the air in running, and as light as is consistent with strength. We are fitted with patterns varying in diameter by Sizes of pulleys  $\frac{1}{4}$  inch up to 12 inches diameter, by  $\frac{1}{2}$  inch up to 20 inches diameter, by 1 inch up to 30 inches diameter, and by 2 inches up to 72 inches diameter. Of these various sizes we make varying widths of face, the

Single belts  
high.

Straight face.

Light pulleys.

Pulleys held  
by set screws.

arms in all cases being proportioned to the work the pulley is expected to do. Thus, for single belts which do not shift upon the pulley we make the pulleys "high" or crowning in the centre of the face, and with rims and arms of adequate strength; if for a double belt, the rims and arms are made stronger in proportion. If for a shifting belt, as are the pulleys on line shaft, which lead on to fast and loose pulleys on the counters, the faces are made straight, and the arms are adapted to the belt intended to be used on the pulley. This may be thought to be a needless refinement; but it affects the cost. If such a system were not adopted, all pulleys would require to be made strong enough for the heaviest work, and those wishing them for light work would have to pay the price of the heaviest; whereas by our system we not only are enabled to sell pulleys at prices varying with their requirements, but such pulleys, when in place, do not contain any superfluous metal to weigh down the shaft and add to the cost of running it.

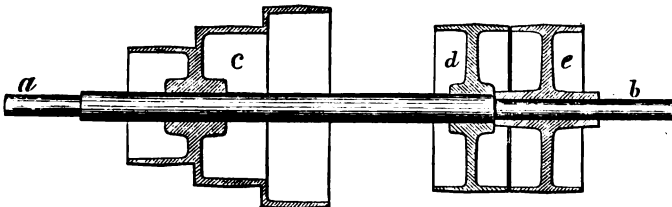
We should in all cases know what kind of belt is to be used on the pulley; but we should also know the speed at which the pulley is to run, as we carefully balance all our pulleys to run without shaking at the required speed. Small pulleys are bored to a size that allows them to slide over the shaft loose and be held by set screws. We so arrange the boring and turning that the pulleys so held run true when fastened by the set screws. Pulleys over 36 inches diameter, 4 inches face, should in all cases be held by keys; if required to be a loose fit, with key and set screws combined. In this case the key seat is straight, not taper; the key must be let into the shaft, the pulley pushed over it, and held in place by the set screws.

In case of large driving pulleys, such as those that receive the belt from engine, the fits should be made on the shaft with the same care as is used in putting on a plate coupling; *i.e.* when we are advised of the position on the shaft (as we should be in all cases) we leave a "fit" part of the shaft larger than the balance of the shaft, and bore the pulley so as to require forcing on with screw press. The advantage of holding the large pulley in this manner is so great that no consideration of false economy, or fear of trouble in getting the work put in place, should deter the user from having this part of the work carefully fitted. In the case of fast and loose pulleys on counter-shaft, we always make the hub of the loose pulley longer than the width of the face of the pulley, and we arrange the hubs of the fast pulley and loose pulley so that they shall meet and keep the edges of the rims apart a proper distance. We can make the loose and fast pulleys to fit the same sized shaft, but our preference is to neck down the counter-shaft at one end to journal size, and place the loose pulleys on this smaller part next to the hanger, so that the oil fed to the hanger will pass also into the hub of the

Loose pulleys

Necking down  
for loose pul-  
leys.

FIG. 21.



loose pulley, and the box of hanger will hold the loose pulley in place. Fig. 21 shows this arrangement.

Counter hang-  
ers.

As counter hangers require no vertical adjustment to keep them in line, we make the box to swivel on a ball joint, in the same manner as in line hanger, but

FIG. 22.

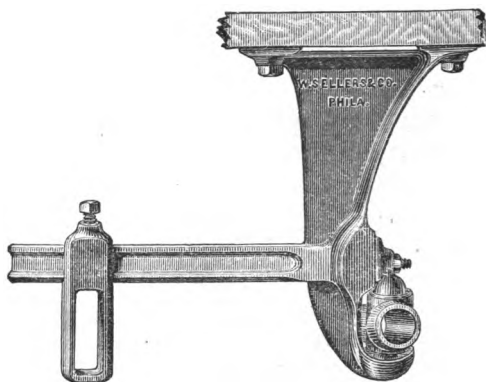
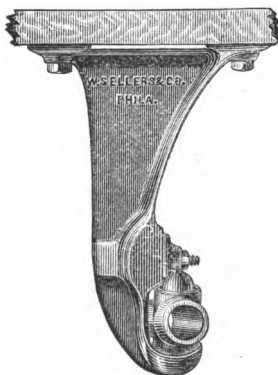


FIG. 23.



Belt-shifter  
arms.

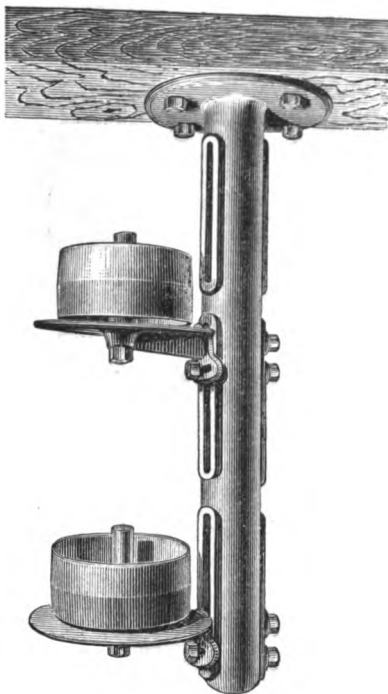
held by a cap only, with a fixed oil dish under the box, and, when required, belt-shifter arms and guides for the belt-shifter rod, as is shown in Figs. 22 and 23.



In substituting belts for gear wheels in the transmission of motion, it must be borne in mind that all possible contingencies of position of shafts one to the other, whether parallel or at any angle, can be more readily met by belts and pulleys, even up to belts 24 inches wide, than with gearing, and in a much more

Turning corners with belts.

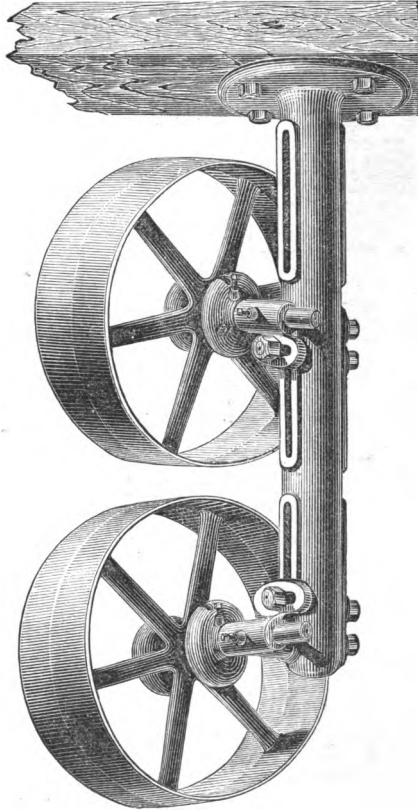
FIG. 24.



satisfactory manner. To meet some of the cases which most frequently occur, for belts of 10 inches and under we arrange "mule pulley stands" (Fig. 24) for **Mule pulleys.**

the transmission of motion to shafts on the same plane or nearly so, and at any required angle to each other.

FIG. 25.

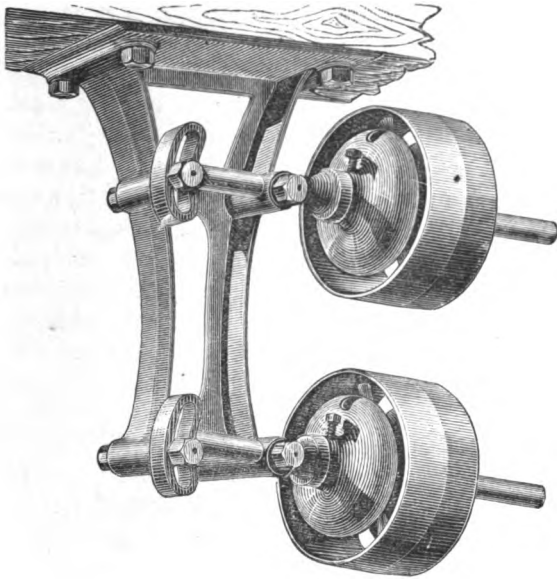


**Large binder  
frame.**

Where the same thing is to be accomplished with the shafts on very different planes, we furnish the "binder frame" (Fig. 25) for cases requiring from

4-inch to 10-inch belts; while for the transmission of power to machines at right angle to line, where the amount of power is not great, say for 3-inch belts, we furnish a smaller "binder frame" (Fig. 26,) admirably adapted to this purpose. This last is largely Small binder frames.

FIG. 26.



used in transmitting from lines to spinning frames which set at right angles to the line: the fast and loose pulleys being on the machine, these frames take the place of counter-shafts.

Where special arrangements are required for the transmission of a large amount of power to shafts at any angle to each other, we have various devices

System of uniform gauge.

Shafting sold by the pound.

applicable to such cases that can be furnished. With us, all that pertains to mill gearing and shafting has been reduced to a systematic manufacture. To make a machine is one thing; to manufacture machines is quite another thing. Thus, one sewing machine may be made by itself at a cost more or less in proportion to the labor expended upon it. But the same machine, by means of organized labor, can be produced in quantities for a tenth of the cost of one machine. Hence systematized manufacture is needed to insure cheap productions. Our hanger and coupling would, indeed, have been expensive luxuries if simply made one at a time, with no special tools fitted to their production; but with such special tools, thorough organization of the labor employed, and the production of immense numbers of them, with all parts made to gauges, and interchangeable, the cost is less now than what the commonest rigid bearing hangers and plate coupling were made for formerly, and their adoption is now universal. Apart from systematized labor, an important item in first cost is weight of material. Not very many years ago, all shafting, and all pulleys, and everything relating to the machine for transmitting motion, were made and sold by the pound. Purchasers were attracted to the makers who charged the least per pound, and no very great care was taken to see that too many pounds did not go into the various parts of the machine. Shafts of a given size could not be made to weigh more or less by different makers; but much needless weight might be put into hangers, into couplings, and into pulleys, so that the price per pound really came to have no meaning, so far as total cost was concerned.

In 1856, feeling that this system of selling hangers,

pulleys, couplings, etc., by the pound, was not the proper way to dispose of such things, we determined on a radical change; we instituted an extensive series of experiments to demonstrate just how strong, and consequently how heavy, each article comprised under this head should be. We found that pulleys might be reduced in weight, and, by the employment of suitable machinery, be more perfectly made; so of hangers, and all that pertains to shafting, except the shafts. We then published a price list, offering to sell each item at some certain fixed price, dependent upon its own cost. The price list enables the purchaser to know beforehand just how much money will be required to obtain what he wants, and for strength and durability he must take the judgment of the makers. There was great opposition to this system from those who were still anxious to sell by the pound; but in time the manifest advantages of the plan caused its adoption by other makers.

Fixed scale of prices.

All conceivable wants of the trade are met by specially contrived devices, which can be made in quantities and kept in stock ready for sale. Hangers varying in size and "drop" (*i.e.* in distance from centre of shaft to the foot) are made from carefully designed patterns. Pulleys fitted for double or single belts, for wide or narrow belts, and made high or straight on the face, are all from patterns nicely adapted to the work each has to do. Last, but not least, all these things are made to standard gauges, so as to have their parts interchangeable. In regard to the sizes mentioned, in speaking of shafts, they are called always from the size of the bar iron from which they are made, and the term "shafting size" has come to have a significant meaning. All turned shafts are

Size of shafts.

made from merchantable sizes of round bar iron, and in turning, one-sixteenth is taken off in diameter, so that what is called a 2-inch shaft is really only one and fifteen-sixteenths in diameter, and so of other sizes; they are all one-sixteenth less than their name implies; and the couplings, hangers, etc., are made to conform to these sizes.

## PATENT INJECTORS FOR FEEDING BOILERS.

IT is not proposed in the following remarks on injectors or continuous boiler feeders to enter into any scientific explanations of the theory of their operations, but to give such practical information as will enable steam users to understand the conditions that should guide them in selecting from the various instruments made by us, and to enable them to use them to the best advantage.

The impression made on most persons at the introduction of the Giffard injector, that its theory of operation was incomprehensible and its practical working involved nice adjustment of parts liable to be easily impaired, made users of the instrument distrustful until familiarity with it had given them confidence. Our construction of the instrument of such a form as to admit of its being readily opened for inspection, tended more than anything else, probably, to do away with this feeling; while, at the same time, its extended use has demonstrated the correctness of the statement of M. Ch. Combes, Inspector-General and Director of the *École des Mines*, who, speaking of the injector for feeding boilers, said, "It is without doubt the best of all those hitherto used for feeding boilers, and the best that can be employed, as it is also the most ingenious and simple, . . . and is theoretically perfect."

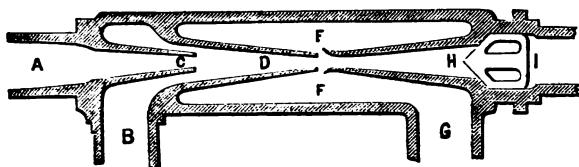
False Impression regarding the injector.

Opinion of M. Ch. Combes.

Simplest form  
of injector.

The injector in its simplest form (all details of construction being intentionally omitted) is shown in Fig. 27. It consists of a pipe *A* for the admission of steam, which, escaping through the nozzle *C* at a high velocity, is joined by water, which, flowing in through the pipe *B*, and passing around the end of nozzle *C*, mingles with and condenses the steam in the conical pipe

FIG. 27.



Names of parts  
of injector.

*D*, and is driven through the pipe *H* and check valve *I* into the boiler; excess of steam or water, from want of adjustment, escaping by the outlet *FF* and pipe *G*.

The parts shown are common to all forms of injectors, under various shapes and modifications, and have been named: *C*, receiving tube; *D*, combining tube; *H*, delivery tube; *I*, check valve; *FF*, overflow; and *G*, overflow nozzle. During the passage of the water from *D* to *H*, it is driven across the space *F*, and if too much water is being supplied to the steam, some water may escape at this point and flow out through the overflow nozzle *G*; while if there be too little water, air will be drawn in at *G* and carried into the boiler with the water.

Fixed nozzle  
injector.

An injector can be made substantially as shown, and its various parts so proportioned as to yield a good result with a given pressure of steam and a fixed quantity of water. Such an instrument is known as a "fixed nozzle injector," and its use will be presently explained.



It will give a constant feed of a given quantity at a given pressure of steam, but cannot be made to vary much in its quantity of delivery. To effect a variation of quantity of water fed, the position of the conical nozzles must be altered in their relation to one another. This alteration, which is an essential feature, was accomplished in the Giffard injector by a spindle in the steam nozzle to contract or enlarge the opening for the discharge of steam, and a movement of the nozzle *C* nearer to or farther from the combining tube *D*, so as to contract or enlarge the annular space between the tubes, to diminish or increase the water supply.

To effect a variation in amount of feed.

Giffard injector.

The Giffard injector was therefore an adjustable nozzle injector,—adjustable in both the water and steam supply within the instrument itself. With this instrument any change in steam supply required a corresponding change in the water supply, and if the proper relation between these parts was not maintained there was either a waste of water from the overflow or an indraught of air at this place. So that if after an adjustment of the parts to produce the best results the steam pressure of the boiler changed, the instrument would work badly until readjusted to the new condition. This led to the introduction of the self-adjusting injector, which is so arranged as to have no waste at the overflow; the steam being adjusted by hand, the instrument itself adjusts the water supply. Thus, when the injector is in operation, any change in boiler pressure makes a corresponding change in the water-flow to the combining tube, and as a result the steam is always combined with the exact quantity of water necessary to produce the best result, with neither waste nor indraught of air. This instrument, which will be described in the proper place, represents

Adjustable nozzle injector.

Proper relation of the parts must be kept up by hand adjustment.

Self-adjusting injector.

Adjusts its own water supply.

Self-adjusting instrument the highest type.

the highest type of the invention, and the one most advantageous to use. But it has within itself certain parts which move and effect this self-adjustment. Some waters deposit large amounts of hard scale, which in time may clog the movements of the parts. When such waters are used,—and, unfortunately for steam users, it is sometimes unavoidable,—the choice must be made of an instrument that will fill the requirements of boiler feed in the best manner admissible under the circumstances. So that to meet all cases of ordinary continuous boiler feed, we offer instruments varied in their arrangements to suit the different circumstances, and varying also in their first cost. These we will describe in detail.

Deposition of  
hard scale  
stops the move-  
ment of parts.

#### THE FIXED NOZZLE INJECTOR A

Can be adjusted, before being put in place, to any given pressure of steam; at that pressure will feed continuously at the maximum, and admits of a very limited variation of steam pressure while working. It will not lift or draw water from a lower level; is simple, and has no moving parts. It admits of being readily taken apart to clean if obstructed by sediment.

Will not lift  
water.

In this instrument there is a fixed receiving tube, the combining tube being adjustable when the instrument is apart. This adjustment permits the instrument to be set at some given pressure of steam, from 5 to 150 pounds boiler pressure, but will work only at or near to the steam pressure at which it has been set. It can be used to advantage in cases where the steam pressure and required feed do not vary much. On locomotives it is applicable as an auxiliary, when the instrument can be located below the level of the bottom of the water tank, so that the water can flow to it. We

Adjustment of  
combining  
tube.

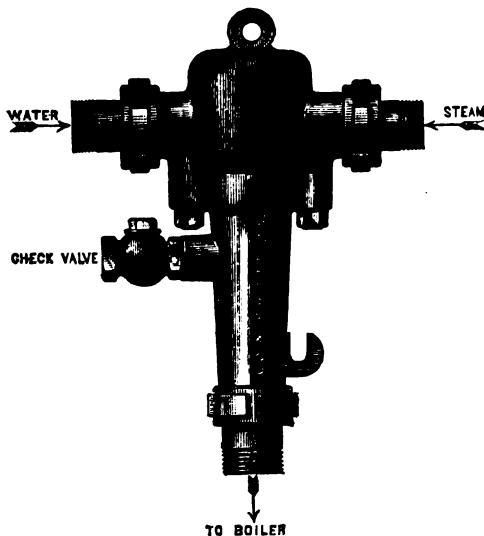
Has no great  
range.

Can be used as  
an auxiliary  
on locomotives

place a check valve opening outward on the overflow nozzle. If the instrument is placed horizontally, there must be an "L-fitting" put between this check and injector to keep the valve of check perpendicular; otherwise it makes no difference in what position the instrument is located. Its maximum delivery is not

Location of  
instrument.

FIG. 28.



so great as the self-adjusting injector. The following table gives the number of cubic feet of water that can be fed by each size of instrument at any given pressure:

*Table of Capacities for Fixed Nozzle Injectors.*

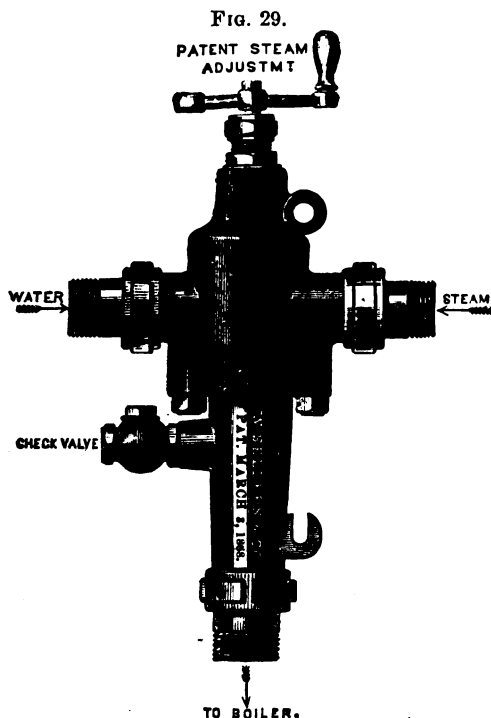
SIZE.	Size of Pipe for Connections.	PRESSURE OF STEAM, IN POUNDS.						
		10	20	30	40	50	60	70
		CUBIC FEET OF WATER DISCHARGED PER HOUR.						
No. 2.....	1½ in.	5.050	6.304	7.344	8.254	9.073	9.824	10.522
" 3.....	¾ "	11.465	14.30	16.658	18.723	20.581	22.284	23.867
" 4.....	1 "	20.50	25.568	29.786	33.476	36.799	39.845	42.674
" 5.....	1¼ "	32.175	40.129	46.748	52.553	57.754	62.536	66.977
" 6.....	1½ "	46.500	57.997	67.564	75.935	83.471	90.381	96.799
" 7.....	1¾ "	50.431	79.184	92.246	103.67	113.96	123.4	132.16
" 8.....	2 "	83.145	103.7	120.8	135.78	149.25	161.6	173.08
" 9.....	2 ¼ "	105.48	131.55	153.26	172.24	189.34	205.01	219.57
" 10.....	2 ½ "	130.5	162.75	189.6	213.1	234.25	253.64	271.65
" 12.....	2 ¾ "	188.6	235.23	274.03	307.98	338.54	366.57	392.6
" 14.....	3 "	257.5	321.15	374.13	420.49	462.23	500.49	536.02
" 16.....	3 ¼ "	337.22	420.59	489.97	550.68	605.34	655.44	701.98
" 18.....	3 ½ "	427.8	533.56	621.59	698.6	767.94	831.5	890.54
" 20.....	3 ¾ "	529.15	659.6	768.83	864.09	949.84	1028.1	1101.5

SIZE.	PRESSURE OF STEAM, IN POUNDS.							
	80	90	100	110	120	130	140	150
	CUBIC FEET OF WATER DISCHARGED PER HOUR.							
No. 2.....	11.436	11.794	12.381	12.941	13.479	13.996	14.493	14.941
" 3.....	25.357	26.752	28.084	29.355	30.574	31.746	32.876	33.89
" 4.....	45.328	47.834	50.215	52.488	54.667	56.762	58.783	60.596
" 5.....	71.140	75.074	78.811	82.379	85.799	89.088	92.259	95.106
" 6.....	102.82	108.5	113.9	119.06	124.0	128.76	133.34	137.45
" 7.....	140.38	148.14	155.52	162.55	169.3	175.79	182.05	187.67
" 8.....	183.84	194.0	203.66	212.88	221.72	230.22	238.42	245.77
" 9.....	233.22	246.12	258.37	270.06	281.28	292.05	302.45	312.05
" 10.....	288.53	304.49	319.64	334.11	347.99	361.32	374.18	385.73
" 12.....	417.01	440.07	461.97	482.89	502.93	522.21	540.8	557.49
" 14.....	569.35	600.83	630.74	659.29	686.66	712.98	738.36	761.14
" 16.....	745.63	786.85	826.02	863.42	899.26	933.73	966.97	996.8
" 18.....	945.91	998.21	1047.9	1095.4	1140.8	1184.5	1226.7	1264.6
" 20.....	1170.0	1234.7	1296.1	1354.8	1411.1	1465.1	1517.3	1564.1

Has no minimum.

FIXED NOZZLE INJECTOR B WITH PATENT  
SPINDLE FOR STEAM ADJUSTMENT.

This instrument is the same in every respect as the fixed nozzle injector A, except the steam adjustment; the steam spindle adds to it the power to lift water, <sup>Will lift water.</sup> say a distance of 8 feet for the smallest instruments,



and more for larger ones: in other respects its operation is the same as the fixed nozzle injector A. Its use on a locomotive would be the same; and it can be

Location of  
instrument.

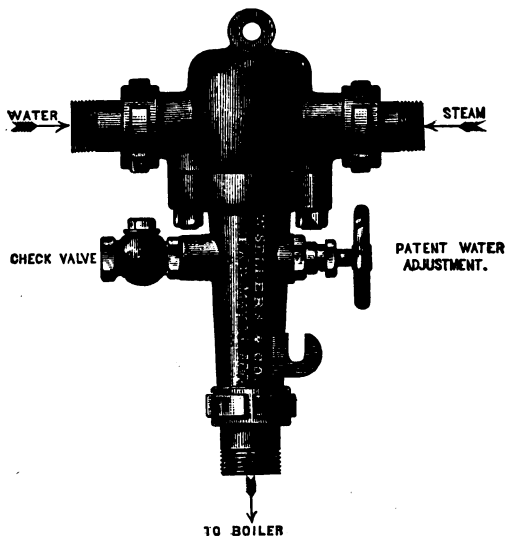
placed higher up on the engine, lifting the water from the tank. It has no minimum. (For table of capacities, see page 188.)

### PATENT ADJUSTABLE WATER NOZZLE INJECTOR C.

Can be adjusted while running.

Capable of being adjusted to suit pressure of steam while running, with very limited range in quantity of water injected at any given pressure of steam. This possibility of adjustment of the combining tube by means of the handle marked "water adjustment" in the cut, Fig. 30, gives the instrument a decided ad-

FIG. 30.

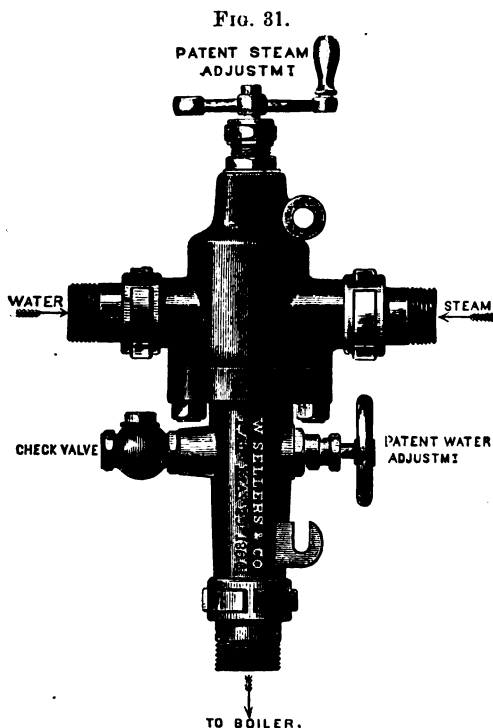


vantage over either the fixed nozzle injectors *A* or *B*, inasmuch as it may be attached to any boiler before the pressure upon the boiler is ascertained,

and upon variation of pressure in boiler it can be readily adjusted. It, in common with the two previously described instruments, works well only at the maximum delivery. (For table of capacities, see page 188.) It can be readily taken apart to clean when obstructed by sediment, and will work from 5 to 150 pounds pressure.

Can be readily cleaned.

PATENT ADJUSTABLE INJECTOR D,  
With steam and water adjustment, provided for as in



## 192 *PATENT INJECTORS FOR FEEDING BOILERS.*

- Simplified.** the original Giffard injector, but very much simplified in its details by dispensing with packing and increasing its efficiency to lift and force water. This instrument
- Has full range.** has the full range of maximum and minimum delivery, but requires to be adjusted by hand, both in
- Will lift water.** water and steam. It will lift water a distance of 8 feet with smallest sizes, and more with larger ones. Will work from 5 pounds to 150 pounds boiler pressure. Can be used with waters forming a sedimentary deposit, and is readily taken apart to be cleaned. It can be placed in any convenient position on a locomotive.



*Table of Maximum Capacities of Patent Adjustable Nozzle Injectors.*

SIZE.	Size of Pipe for Connections.	PRESSURE OF STEAM, IN POUNDS.						
		10	20	30	40	50	60	70
		CUBIC FEET OF WATER DISCHARGED PER HOUR.						
No. 2.....	1/2 in.	5.050	6.304	7.344	8.254	9.073	9.824	10.522
" 3.....	3/4 "	11.465	14.30	16.658	18.723	20.581	22.284	23.867
" 4.....	1 "	20.50	25.568	29.786	33.476	36.799	39.845	42.674
" 5.....	1 1/4 "	32.175	40.129	46.748	52.553	57.754	62.536	66.977
" 6.....	1 1/2 "	46.500	57.997	67.564	75.935	83.471	90.381	96.799
" 7.....	2 "	50.431	79.184	92.246	103.67	113.96	123.4	132.16
" 8.....	2 1/2 "	83.145	103.7	120.8	135.78	149.25	161.6	173.08
" 9.....	3 "	105.48	131.55	153.26	172.24	189.34	205.01	219.57
" 10.....	3 1/2 "	130.5	162.75	189.6	213.1	234.25	253.64	271.65
" 12.....	4 "	188.6	235.23	274.03	307.98	338.54	366.57	392.6
" 14.....	5 "	257.5	321.15	374.13	420.49	462.23	500.49	536.02
" 16.....	6 "	337.22	420.59	489.97	550.68	605.34	655.44	701.98
" 18.....	8 "	427.8	533.56	621.59	698.6	767.94	831.5	890.54
" 20.....	10 "	529.15	659.6	768.83	864.09	949.84	1028.1	1101.5

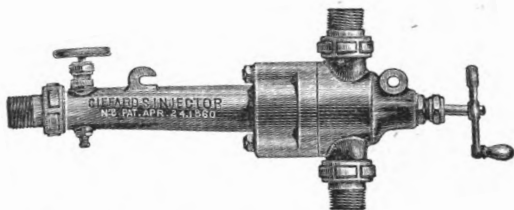
SIZE.	PRESSURE OF STEAM, IN POUNDS.							
	80	90	100	110	120	130	140	150
	CUBIC FEET OF WATER DISCHARGED PER HOUR.							
No. 2.....	11.436	11.794	12.381	12.941	13.479	13.996	14.493	14.941
" 3.....	25.357	26.752	28.084	29.355	30.574	31.746	32.876	33.89
" 4.....	45.328	47.834	50.215	52.488	54.667	56.762	58.783	60.596
" 5.....	71.140	75.074	78.811	82.379	85.799	89.088	92.259	95.106
" 6.....	102.82	108.5	113.9	119.06	124.0	128.76	133.34	137.45
" 7.....	140.38	148.14	155.52	162.55	169.3	175.79	182.05	187.67
" 8.....	183.84	194.0	203.66	212.88	221.72	230.22	238.42	245.77
" 9.....	233.22	246.12	258.37	270.06	281.28	292.05	302.45	312.05
" 10.....	288.53	304.49	319.64	334.11	347.99	361.32	374.18	385.73
" 12.....	417.01	440.07	461.97	482.89	502.93	522.21	540.8	557.49
" 14.....	569.35	600.83	630.74	659.29	686.66	712.98	738.36	761.14
" 16.....	745.63	786.85	826.02	863.42	899.26	933.73	966.97	996.8
" 18.....	945.91	998.21	1047.9	1095.4	1140.8	1184.5	1226.7	1264.6
" 20.....	1170.0	1234.7	1296.1	1354.8	1411.1	1465.1	1517.3	1564.1

Minimum capacities 60 per centum of the maximum.

PATENT SELF-ADJUSTING INJECTOR

Will work with from 5 pounds up to 150 pounds boiler pressure. Will perform a higher "duty" than any

FIG 32.



Improvements  
increasing its  
efficiency.

other form of injector. Is simple and easily kept in repair; starts readily, and will not stop or knock off from irregularities in flow of steam. The superior advantages of this instrument warrant our dwelling on its details of construction, more particularly as we have lately made important improvements in it, making it less liable to stop from dirt or sedimentary deposits than heretofore.

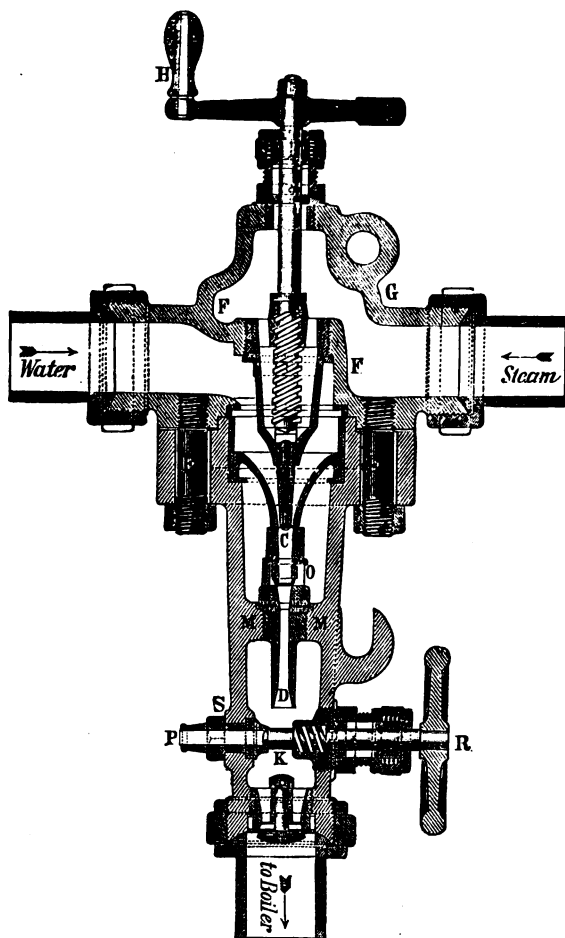
The annexed sectional cut, Fig. 33, shows the instrument in its most improved form.

Outer shell.

The outer shell, or case, consists of two parts, united by bolts, *EE*. The part *GG* is provided with two inlets, the one for steam, the other for water, as shown in the cut, the two being separated by the plate, *FF*, in the centre of which is attached a nozzle, called the receiving tube, *A*, for the steam jet. The amount of steam which may be discharged by this nozzle is regulated by the tapered plug, which is operated by the screw, *B*, and exterior handle, *H*. The interior of the case, *EE*, is bored out for a short distance, and fitted with a lining of brass, turned out to receive the

Steam spindle.

FIG. 33.



**Combining  
tube.**

**Guide for com-  
bining tube.**

**Waste valve.**

piston, *NN*, which plays freely along it. This piston forms the upper or receiving end of the converging pipe, *C*, called the combining tube. The lower end of this tube is exteriorly cylindrical, and slides in a guide at the upper end of the delivery tube, *D*, which is stationary, being screwed into the outer shell at *MM*.

Beyond this point, again, a small stop valve, *PR*, affords, when open, a lateral outlet to the tube, *K*; and beyond this, again, a check valve is placed between the instrument and the boiler.

To put this apparatus in operation, the stop valve, *PR*, is opened, and the steam plug, *B*, is closed; a little steam being let in, will escape through the small hole in the end of the steam plug, producing a vacuum, when the water is drawn up and forced through *C* and *D* into the pipe, *K*, from which it escapes by *P*. The plug, *B*, is then drawn back, so increasing the supply of steam, until the stop valve, *R*, can be closed, without causing the injector to cease working. This ceasing to work will be indicated by an escape of steam from the water-supply pipe. The action which is taking place in the apparatus, when thus in operation, may be briefly described as follows:

**Mode of opera-  
tion.**

The steam passing into *C* is condensed by the water there combining with it from the water supply, and the concentrated jet is then driven through the delivery tube, *D*, into the pipe, *K*, from which, by raising the check valve beyond, it passes into the boiler.

**Self-regula-  
tion.**

If now the water supply is, or becomes, too great, a portion of water escapes by the opening, *O*, in the upper part of the delivery tube, and, accumulating in the surrounding chamber, forces back the piston, *NN*, which, of course, carries with it the tube, *C*, etc., thus diminishing the annular space through which the

water enters the combining tube, and so limiting its supply. If, on the other hand, the supply of water is not sufficient, the velocity of the steam jet will be increased, and a partial vacuum will be produced in the chamber, and the piston, *NN*, will consequently be brought downward, thus opening the space for water supply, and correcting the defect.

We thus see that the instrument is self-regulating, and will adapt itself to changed conditions of pressure, so as always to develop a maximum result proportioned to the quantity of steam used.

There are, besides this general principle and action, several other points claiming notice in this form of the instrument.

Thus, the waste pipe, *P*, must be of sufficient size to allow the smallest quantity of water which the injector will feed when in action, to pass through the pipe, *D*, under a pressure less than that in the boiler; for if this is not the case it will be impossible to start the instrument, as the jet would break so soon as the valve, *PR*, is closed.

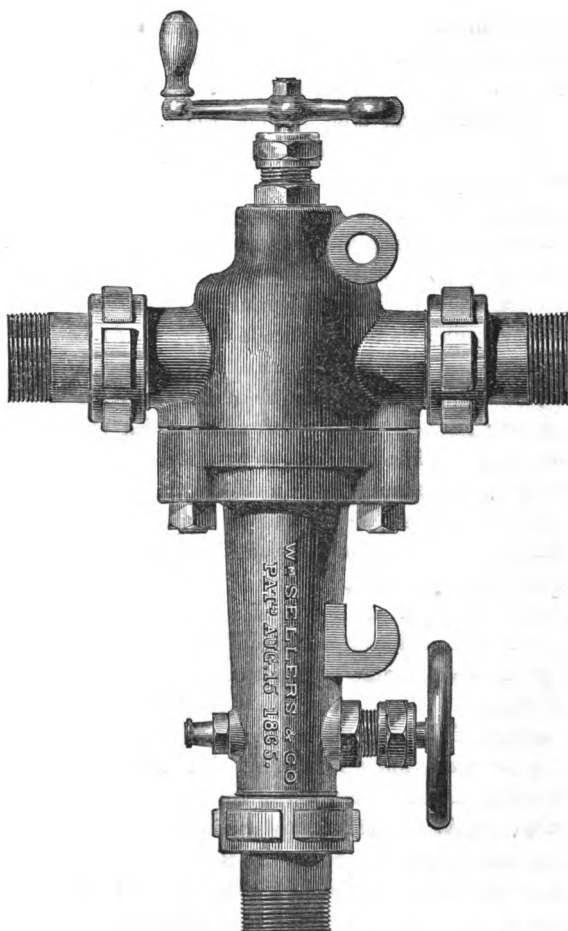
Size of waste pipe.

The same result would follow if a pipe of some length were attached to the outlet, *P*, as this pipe would check the discharge by the frictional resistance of its sides.

The reason of this is, that before the injector can begin to introduce water into the boiler, a stream must have been established, filling the pipe, *D*, and moving with sufficient velocity to enable it to overcome the resistance of the boiler. It is clear that the outlet at *P* must be able to deliver this stream freely, or such a pressure would be produced in the space, *K*, as would prevent the stream in *D* from acquiring the necessary velocity.

Need of velocity of jet.

FIG. 34.



It is therefore evident that in any case where the waste is to be carried away by a pipe connected with *P*, this pipe must be of sufficient diameter to avoid such resistance as has been noticed. Practical experience has shown that, for a pipe of moderate length, a diameter at least twice that of the outlet, *P*, is requisite.

It will be observed, also, that the conical plug, *B*, for regulating the steam supply, has a narrow passage bored along its axis, which communicates, by transverse openings, with the steam space around it.

Centre hole in  
steam spindle.

By this means, when the plug, *B*, is forced all the way down, so as to close the outlet, *A*, a small jet of steam will pass by the opening in the plug, and will exert a much greater lifting force to raise water from the supply into the combining tube, *C*, than will be produced by a jet of steam through the annular space between the plug, *B*, and nozzle, *A*.

The reason of this is, in part, as follows: To produce this lifting effect, which is quite dissimilar from that of the injector in its operation connected with the introduction of water into the boiler, and is more nearly allied to the action of the exhaust in producing a draft in the smoke-stack of a locomotive; the effect depends chiefly on the free expansion and high velocity of the steam jet at the moment it escapes from the nozzle, *A* (or the centre of plug, *B*), and upon the existence of an outlet beyond, *C*, not only sufficient to allow this expanded steam jet to pass freely, but also to give an exit to the air carried with it by friction.

The reason it  
aids in lifting  
water.

Now, in all these respects, the annular jet between the plug, *B*, and nozzle, *A*, is at great disadvantage, as compared with the orifice in the centre of plug, *B*.

Thus the friction is immensely greater in the an-

Height to  
which it will  
lift water.

nular jet, thereby reducing the velocity, especially if this jet is but slightly open ; while, on the other hand, if more space is given in the annular jet, the amount of steam discharged will be more than can pass freely by the nozzle, *C*, thus rather tending to produce a back pressure than a vacuum, in *C* and the water-supply pipe. In fact, it is found that where, with the old arrangement, an injector is able to raise its feed (water) from 2 to 6 feet, with this modification it will lift its supply from 10 to 18 feet, depending upon the size of the instrument. In this connection it is proper to call attention to the necessity for excluding air from the water-supply pipes ; any leak of this kind will not only impair the vacuum, but also, as air does not change its form or lose its elasticity when in contact with water, its presence in the steam jet will diminish the density of the jet and impair its ability to penetrate the boiler.

The exterior appearance of this instrument is shown in Fig. 34.

Combining  
tube is not  
subjected to  
boiler pressure.

The adjustment of the water supply to suit the steam pressure and steam supply also is effected, as has been seen, by the motion of the combining tube, *C*, towards the delivery tube, *A*, to decrease the water supply, and away from it to increase the water supply. This motion is effected by the piston, *NN*, which, except when moving, is in equilibrium so far as pressure on either side of it is concerned ; so also with the guide at the lower end of the combining tube : this is steadied by sliding in a prolongation of the delivery tube, *D*, above the point of overflow, *O*. Accuracy of fit in these parts is not needed, as they are not in any case subjected to boiler pressure. The combining tube should play freely up and down in the case, and

Need not be a  
close fit.

Should play  
freely in the  
chamber.



is held rigidly in place when working by the operation of the jet, and so long as it can move freely it will continue to act. We have said that the patent self-adjusting injector is at all times working to the best advantage (see page 185), throwing all the water possible with any given quantity and pressure of steam. This form of injector is so much more efficient than any other, that the maximum quantity any one size will deliver is as much as the next larger size of any of the old styles of injectors, as will be seen by comparing the table of maximum capacities of self-adjusting injectors, given on the next page, with that for the fixed nozzle and adjustable nozzle injectors, given on page 193. This must be taken into consideration in comparing the cost of the different kinds of injectors.

Is always working to the best advantage.

Comparison of quantity.

The greater capacity should be considered.

Referring to the notes at the foot of the respective tables, that the minimum capacity of the self-adjusting injector is 50 per cent. of the tabular capacity (which shows the maximum delivery), while with the fixed nozzle and adjustable nozzle injectors the minimum is not so low, being about 60 per cent. of the maximum, it will be readily seen that the self-adjusting injector to a higher maximum than any other form of injector adds an increased range.

# 202 PATENT INJECTORS FOR FEEDING BOILERS.

*Table of Maximum Capacities of Patent Self-Adjusting Injectors.*

SIZE.	Size of Pipe for Connections.	PRESSURE OF STEAM, IN POUNDS.						
		10	20	30	40	50	60	70
		CUBIC FEET OF WATER DISCHARGED PER HOUR.						
No. 2.....	1/2 in.	8.3	9.	9.7	10.4	11.1	11.8	12.5
" 3.....	3/4 "	19.27	21.04	22.81	24.58	26.35	28.12	29.89
" 4.....	1 "	36.66	39.8	42.74	45.88	49.02	52.16	55.3
" 5.....	1 1/4 "	57.58	62.5	67.42	72.34	77.26	82.18	87.1
" 6.....	1 1/2 "	83.48	90.6	97.72	104.84	111.97	119.09	126.21
" 7.....	2 "	114.03	123.75	133.48	143.2	152.93	162.65	172.38
" 8.....	2 1/2 "	149.2	162.	174.8	187.6	200.4	213.2	226.
" 9.....	3 "	189.2	205.35	221.51	237.66	253.82	269.97	286.13
" 10.....	3 1/2 "	233.84	253.8	273.76	293.72	313.68	333.64	353.61
" 12.....	4 "	337.2	366.	394.8	423.6	452.4	481.2	510.
" 14.....	4 1/2 "	451.49	491.45	531.41	571.36	611.32	651.27	691.23
" 16.....	5 "	600.32	651.6	702.88	754.16	805.44	856.72	908.
" 18.....	6 "	760.07	825.	889.93	954.86	1019.78	1084.71	1149.64
" 20.....	6 1/2 "	938.84	1019.	1099.16	1179.32	1259.48	1339.64	1419.8

SIZE.	PRESSURE OF STEAM, IN POUNDS.							
	80	90	100	110	120	130	140	150
	CUBIC FEET OF WATER DISCHARGED PER HOUR.							
No. 2.....	13.2	13.9	14.6	15.3	16.	16.7	17.4	18.1
" 3.....	31.66	33.43	35.2	36.97	38.75	40.53	42.31	44.09
" 4.....	58.44	61.58	64.72	67.86	71.	74.14	77.28	80.42
" 5.....	92.02	96.94	101.86	106.78	111.7	116.62	121.54	126.46
" 6.....	133.33	140.45	147.57	154.7	161.82	168.94	176.06	183.18
" 7.....	182.1	191.83	201.55	211.28	221.	230.73	240.46	250.19
" 8.....	238.8	251.6	264.4	277.2	290.	302.8	315.6	328.4
" 9.....	302.28	318.44	334.59	350.75	366.9	383.07	399.23	415.39
" 10.....	373.57	393.53	413.49	433.45	453.41	473.37	493.33	513.29
" 12.....	538.8	567.6	596.4	625.2	654.	682.8	711.6	740.4
" 14.....	731.18	771.14	811.09	851.05	891.	930.97	970.93	1010.89
" 16.....	959.28	1010.56	1061.84	1113.12	1164.4	1215.68	1266.96	1318.24
" 18.....	1214.57	1279.5	1344.42	1409.35	1474.28	1539.21	1604.14	1669.07
" 20.....	1499.96	1580.12	1660.28	1740.44	1820.6	1900.76	1980.92	2061.08

The minimum capacity 50 per centum of the maximum.

The numerical size of any injector is the diameter of the smallest part of the delivery tube expressed in millimetres. Thus, in a No. 2 injector the water is driven through an opening 2 millimetres in diameter, while in a No. 10 it passes through a hole 10 millimetres in diameter. The quantity of water that can be made to pass through this opening depends upon two conditions: the pressure of the steam, and the temperature of the water before it enters the instrument. The colder the water, the higher pressure of steam may be used to inject it. The hotter the water before it enters the injector, the lower must be the pressure of the steam. Thus, an instrument that with water at 70° Fahrenheit will *only* work up to 150 pounds of boiler pressure, will not work at that pressure if the water used be more than 70°. So that if hot water is to be used with any injector, it must be remembered that low steam only can be used in the following proportions, unless the proportions of the tubes be correspondingly changed:

Nominal size of injector.

Conditions which control the amount of feed.

Cold water better than hot.

Low steam only with hot water

Temperature of feed water before it enters injector.....	148°	138°	130°	124°	120°	110°	90°
Pressure of steam, in pounds, per square inch.....	10	20	30	40	50	100	120

To determine the size of instrument needed for any particular case, a knowledge of the number of cubic feet of water required per hour will enable an instrument to be selected, by referring to the table of capacities for any special kind of instrument. When horse-power is known, the quantity of water may be approximately assumed by considering each horse-power to require one cubic foot of water per hour. But if the steam is used expansively to any great extent, as

To determine size of instrument required

Horse-powers and water required.

Too large an instrument objectionable.

in some of the best modern engines, the quantity of water per horse-power might be reduced say 33 per cent. But in no case should the injector selected be larger than will give at maximum the number of cubic feet of water corresponding with the number of horse-power, inasmuch as the range of the instruments is limited to from 50 to 60 per cent. of the maximum capacity; and if too large an instrument is selected, the minimum may sometimes be too great for the wants of the boiler, requiring frequent stoppages to prevent flooding; which, apart from the trouble involved, is not so economical as a constant and regular feed equal to the drain on the boiler.

Approximate horse-power of boiler.

Grate area.

Fire surface.

When great range is needed.

To approximate the horse-power of any boiler, the following rules are useful. When area of grate surface is known: Area of grate in square feet  $\times 1.6 =$  horse-power. In case of plain cylinder boilers, if the heating surface of boiler be known in square feet, divide by 10 for horse-power. In case of flue boilers, divide heating surface by 12; and with multitubular boilers, divide by 15 for the number of horse-powers.

There are some cases in which the range required is greater than any one instrument is capable of accomplishing, as in some cases of locomotives, where varying loads and varying grades make greater variation in the quantity of water required. Instances have occurred where a No. 4 injector is ample for some part of the road and with some loads, while a No. 8 is needed at other times. This necessitates the application of several different sizes of injectors, or the frequent stoppage of a large one when little water is being used. To meet this case, we offer an injector embodying new principles, occupying but little space, and extending in its range from its maximum to a mini-

mum of less than one-quarter of its maximum, filling entirely the wants of locomotive practice with variable loads and grades. This instrument, which we call our

# PATENT VARIABLE NOZZLE INJECTOR,

is shown in Fig. 35. It occupies but little more space than a No. 8 injector, and is readily manipulated. We maintain the self-regulating principle, and effect the steam regulation in the same manner as in our other instruments, by means of the crank handle (*a*). Within the "case" of the instrument, combining and delivery tubes for four sizes of injectors are arranged in a circle in such a manner that any one of them may be brought into the centre of the instrument, and thus the working size of the injector is adapted to the requirements. In other words, four different sizes of instruments, forming a continuous range from the smallest to the largest, are united in one "case." The crank handle, *a*, is capable of three revolutions back and forth: one-fourth of each revolution is taken to effect the change of nozzles, one-fourth is allowed for margin in the movements, and one-half of each revolution is used to effect the steam regulation for each size, from maximum to minimum. There is a lever, *b*, provided, operating a central spindle, which is pushed down to facilitate starting, but must be drawn up to give the required amount of steam. All the precautions observed in setting the self-adjusting injector are to be attended to in placing this one. The starting valve, which should be used with this injector, has a special provision to give a small amount of steam to the smallest size of nozzles. The range of this instrument extends downward from the maximum of a No. 8 self-adjusting injector to the least quantity any loco-

Size of instrument.

Four injectors combined in one.

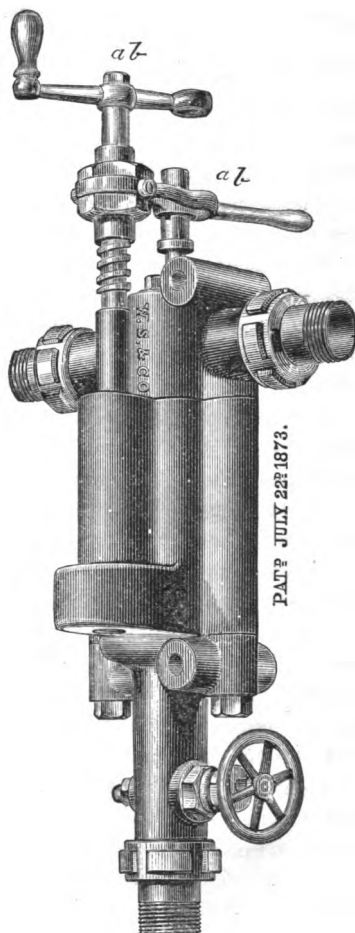
Crank handle.

Steam plug lever.

Precautions in setting.

Range.

FIG. 35.



motive practice requiring so large an instrument will ever need.

It is of the utmost importance that care be taken in setting all kinds of injectors by those who attach them to the boilers; and there are some particulars that may be mentioned as holding in common with all kinds of injectors. Among these may be noted :

Rules for setting.

FIRST. All pipes, whether steam, water-supply, or delivery, must be of the same internal diameter as the hole in the corresponding branch of each injector, and as short and straight as practicable.

Size of pipes.

SECOND. When floating particles of wood or other matter are liable to be in the supply water, place a wire screen over the receiving end of water-supply pipe, taking care to have the meshes as small as the smallest opening in the delivery tube, and the total area of meshes much greater than the area of water-supply pipe, to compensate for the closing of some of them by deposit.

Screen over water-supply pipe.

THIRD. The steam should be taken from the highest part of the boiler, to avoid priming, but should not be attached to the steam pipe leading to an engine unless this pipe is large: sudden variations in pressure may break the jet in the old styles of injectors, and would produce a constant movement of the piston in the self-adjusting.

Dry steam should be used.

FOURTH. When any injector capable of raising water is set so as to lift the water, care must be taken to have the pipes very tight, so as not to draw air; and it is of importance that in any arrangement of instrument the water supply should be unmixed with air, which will cause a sputtering sound, and is liable to break the jet.

Lifting water.

Must not draw air.

FIFTH. If the water is not lifted by the injector,

## 208 PATENT INJECTORS FOR FEEDING BOILERS.

**Injector fed from hydrant.** but flows to it from a tank or hydrant, there should be a cock in the water-supply pipe.

**Cocks needed.** **SIXTH.** There must always be a stop valve or cock in the steam pipe between the steam space in boiler and injector, and a check valve between the water space of boiler and the injector. In addition to the above, certain precautions must be taken in setting the patent self-adjusting injector :

**FIRST.** There must be in the water-supply pipe an alarm check valve, with waste check attached, as shown in Plates II. and III.

**Water regulating valve.**

**SECOND.** When fed with water under pressure, ANY CONSIDERABLE PRESSURE IN THE WATER-SUPPLY PIPE MUST BE AVOIDED. We supply a water regulating stop valve, to be used when the water pressure in the supply pipe is too great.

**See that pipes are all clear.**

After all the pipes are properly connected to the injector and boiler, and before admitting steam to the injector, it should be disconnected again from the pipes at the three union joints, and the steam and water should be allowed to flow through the pipes, to remove any red lead, or scale and other solids, from the interior of the pipes. This precaution will avoid trouble at first starting, which otherwise is liable to occur.

**Extra attachments.**

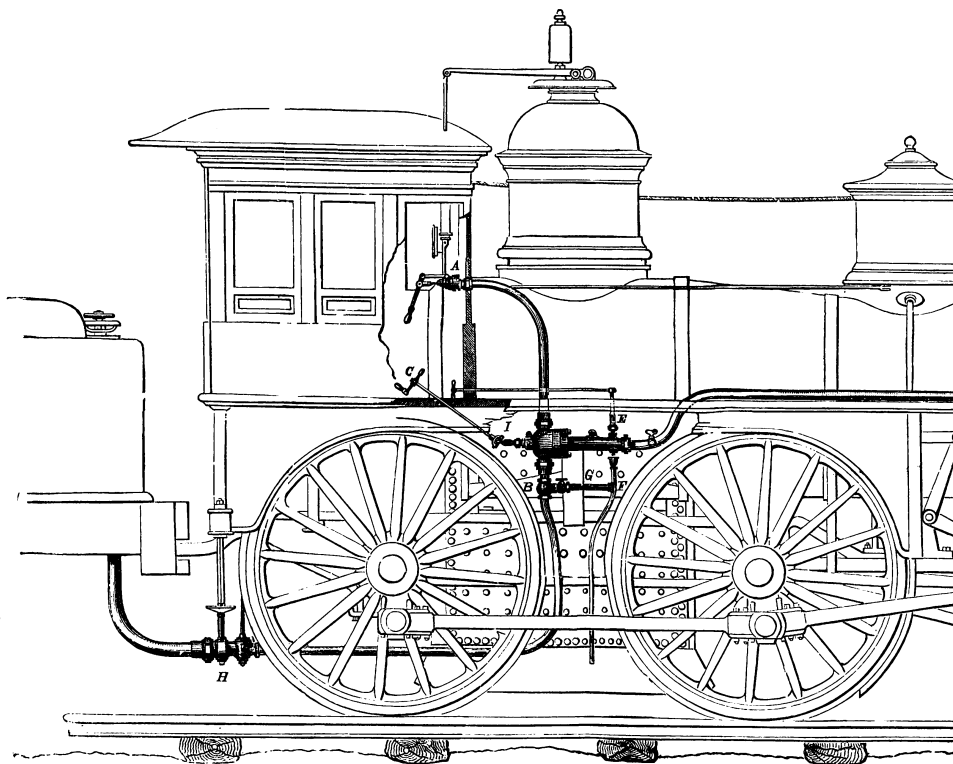
To facilitate the efficient use of the instrument, we have arranged special attachments, such as starting valves and the like, for the two distinct uses to which these instruments are put, viz., to locomotives and to stationary boilers. Plate I. shows one method of attaching the injector to locomotives.

**On locomotives above the tank.**

It is not imperative, nor even important, that the injector should be placed upon the locomotive just as it is represented in the cut ; but it is all-important that







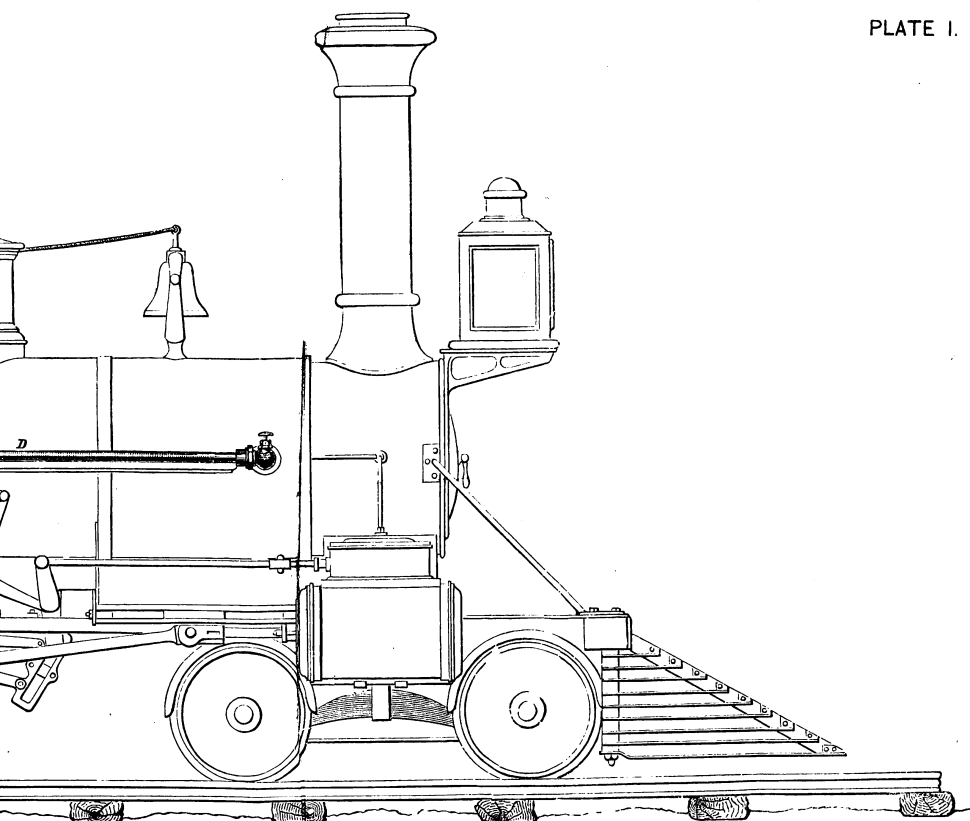
## POSITION OF INJECTOR AND

TO START

- A. Steam Valve.
- B. Check Valve in the Water Supply.
- C. Regulating Handle.
- D. Delivery Pipe to Check Valve on Boiler.
- E. Escape or Waste Valve.
- F. Waste Pipe at least twice the diam. of Escape Opening
- G. Alarm Check and Pipe to Waste Pipe.
- H. Drip Cock in Feed Pipe.
- I. Universal Joint.

1st. Screw down Handle C. 2d. Valve A a little, until water flows A wide. Screw out Handle C, until it does not cause any discharge from F. Then screwing out to increase delivery, and

N. B.—A failure to work will be caused by steam and water from Alarm Check Valve. Handle C is too far down. Mark



# ACCESSORIES ON A LOCOMOTIVE.

## THE INJECTOR:

Open Waste Valve E. 3d. Open Steam Valve A. Then open Valve B until the closing of Waste Valve E will stop the flow of water. Regulate by Handle C, and in to diminish it.

It will always be indicated by a discharge of water from Check G, and will take place whenever the water reaches this point.

## To use the instrument as a Heater for Tank:

Close the Waste Valve E and admit the steam from the Steam Valve A. In this case a small cock will be required on Waste Pipe G which must be closed when heating feed water. After using the Injector for this purpose, the hot water in Feed Pipe must be drawn off through the Drip Cock H before the Injector can be used to feed the boiler.



it should be placed so that its alarm must attract attention, and that the operator can manipulate it without moving from his ordinary position or taking his eye from the road; when these points can be secured, and the injector can be placed low enough to permit the water to flow through it, air will be excluded from the water supply, and an accidental supply of hot water can be readily discharged by flowing it through the waste valve, *E*; but these advantages should never be sought by sacrificing those referred to.

Some locomotive builders place the instrument below the lowest water level in tank; and for convenience of manipulation in such cases we furnish, when desired, a universal joint, to enable the extension rod from steam spindle to be carried to a convenient place in the cab.

On locomotives  
below the  
tank.

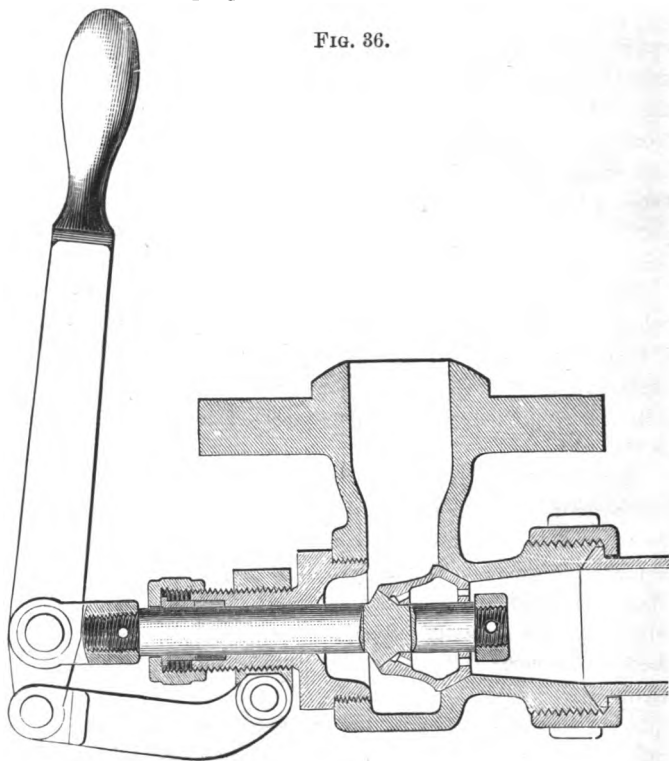
It is of the utmost importance that the appliances needed to work the injector, such as starting cock and the various other valves, especially on locomotives, should be of the best construction. We have arranged these accessories with a view both to convenience, durability, and greatest efficiency. Prominent among these "locomotive attachments" is the **STARTING VALVE**.

Starting valve

It is necessary in starting the instrument, particularly when it is required to lift water, that there should be a small supply of steam at first to bring the water up to the nozzle, and afterwards the full supply should at all times be given. Our starting valve, shown in Fig. 36, is operated by a lever, *A*; its stem, *B*, is attached to the valve *D*, with a lost motion between *C* and *E*. *C* is in fact a small valve in the centre of the larger valve, *D*. Pressure of the boiler

Use of centre valve. is on top of valve on space *G*. Raising the lever and drawing up the valves, *C* will leave its seat on *D*,

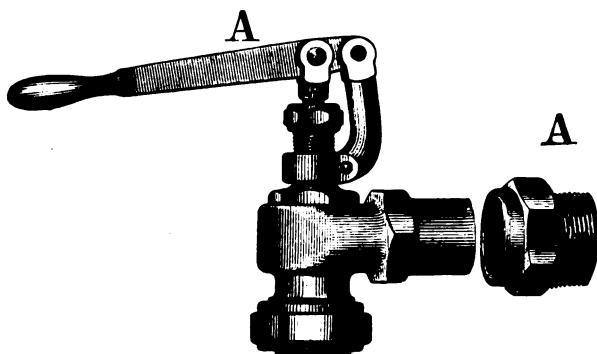
FIG. 36.



until a check nut at *E* has brought up against *D*. This resistance can be distinctly felt, and indicates when the small valve only is open. Through this small valve enough steam will pass to start the jet. A further motion of the lever then raises the large valve, and the pressure acting on the stem, *B*, forces it wide open and holds it in this position. These valves

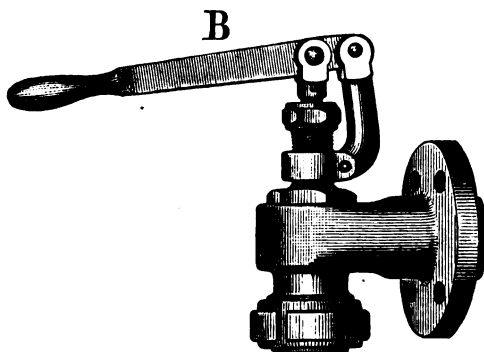
are, for convenience of attachment to boiler, made either with or without flanges, as shown in the annexed cuts.

FIG. 37.



(A.) STARTING VALVE, WITHOUT FLANGE.

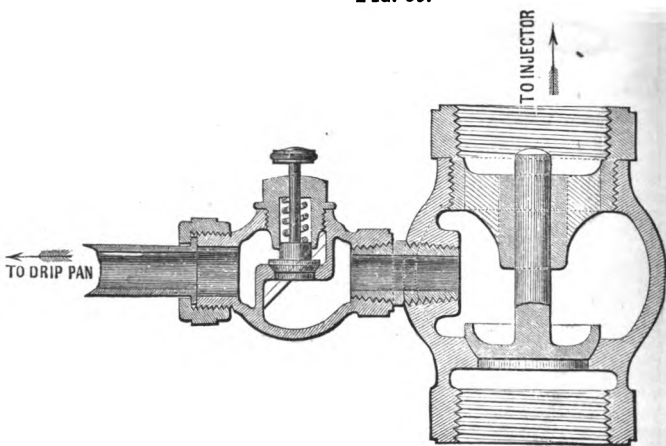
FIG. 38.



(B.) STARTING VALVE, WITH FLANGE.

As it is of vital importance that the engine driver should be notified whenever the injector, from any cause, either ceases to operate or fails to start, we  
**Alarm check.** provide an alarm check valve, shown in Fig. 39, as also in place in Plate II.

FIG. 39.



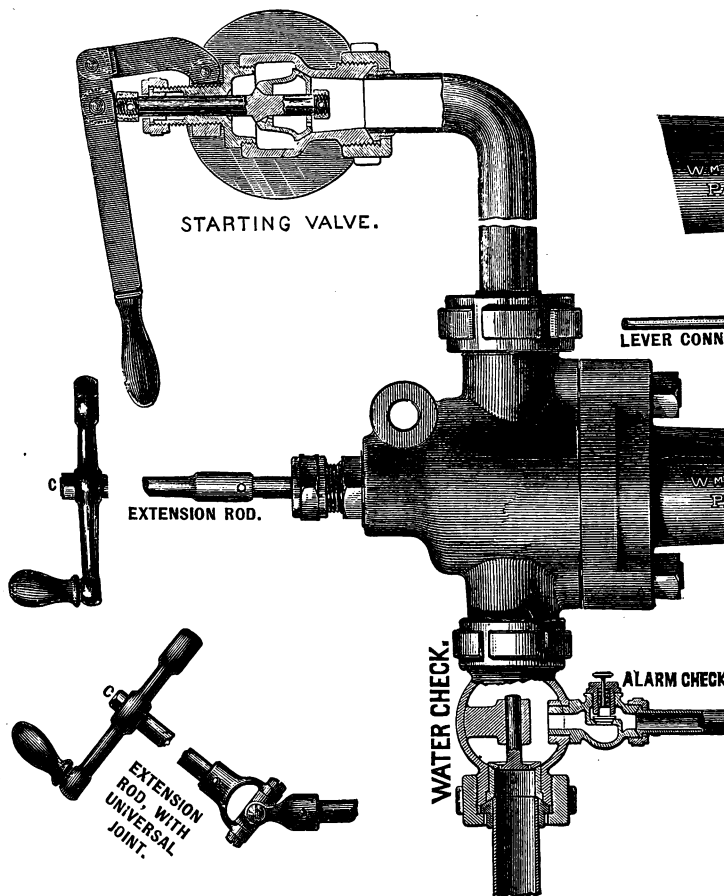
If steam flows back it is partially stopped by check *B*, and, acting under check valve *D*, raises it, and blows out through the waste pipe.

**Water heater.** To enable the instrument to be used as a tank heater in cold weather, it is only necessary to close the waste valves of injector before turning on steam, when the jet cannot be established, but the steam will blow back through the instrument, and, passing through small holes in the valve *B* of water check, will enter the tank and warm the water. A stop valve must be placed in the pipe from the alarm check, to be closed when the steam is being forced into the tank; else it will escape through the alarm check.



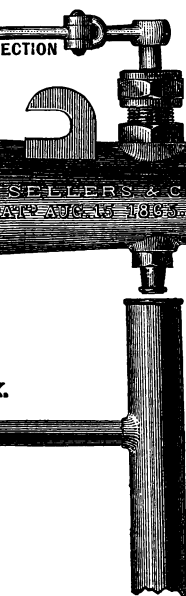
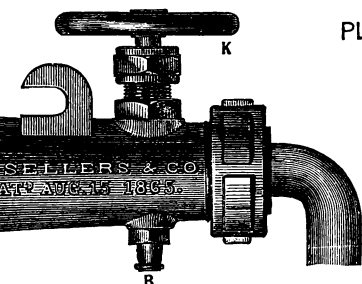


# LOCOMOTIVE AT

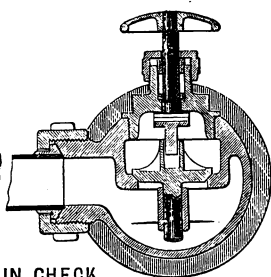


# ATTACHMENTS.

PLATE II.



The Extension Rod and Lever Connection are not required when the Balance Wheel K can be conveniently reached by the operator.





It must, of course, be remembered that, after driving steam through in this way for some time, the feed pipe and its contents will become highly heated. It will, therefore, be impossible to start the injector until this very hot water has been drawn through and ejected by the escape valve.

The instrument will not start if too hot.

If this precaution is neglected and the full head of steam is given to the injector before the hot water has all been expelled by the light jet, then, there being no condensation in the nozzle *C*, Fig. 33 (or an insufficient one), the jet will not be driven into the boiler, but will back up into the supply pipe, and will drive hot water and steam through the supply pipe to the tank, thus re-establishing the conditions securing failure; so that if another attempt is made at once to start the apparatus, it will fail, exactly as before, and so on perpetually, until the water in the supply pipe is no longer hot; an end to be reached in practice, of course, not by waiting until it cools, but by blowing it out, as before directed.

To facilitate this cooling process, it is advisable to place a small drip cock on the lowest part of the supply pipe between the tank and the injector, as shown at *H*, Plate I.

Cooling the injector.

We come, lastly, in connection with these locomotive attachments, to the main check valve. The object of this, evidently, is to prevent the water of the boiler from running out through the injector, should anything go wrong.

Main check valve.

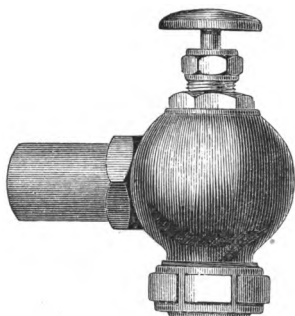
It is, moreover, so constructed that it not only acts as an automatic check valve, but it is also arranged so that if, by chance, it sticks up and fails to close, it may be forced down into its seat, and turned round so as to remove obstructions. (See Plate II., main check.)

To accomplish these objects, the upper part of the valve is provided with parallel plates cast with it, forming, in fact, a rectangular slot, in which fits freely a plate suspended from the T slide of the valve stem which ends above in a button. By this means the valve easily rises and falls, being guided by the part of the stem below the valve; but if it should stick up, it may be at once forced into its seat by pressing on the button, or turned round upon its seat so as to grind out any foreign substance without cramping its guiding stem.

These check valves are made for either right or left side of the locomotive, and with or without flanges, as shown in the annexed cuts (Figs. 40–45).

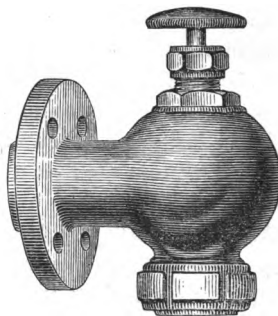
#### MAIN CHECKS.

FIG. 40.



(C.) INGRESS AT BOTTOM, FOR RIGHT OR LEFT SIDE, WITHOUT FLANGE.

FIG. 41.

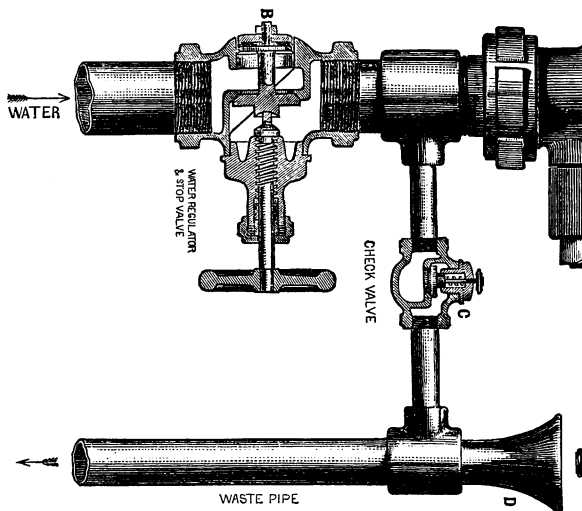


(D.) INGRESS AT BOTTOM, FOR RIGHT OR LEFT SIDE, WITH FLANGE.

In connection with stationary engines, the only attachments required are the alarm check, main check, and, when there is pressure in the water supply, a water regulator in connection with the water check valve.



STATIONARY ATTACHMENTS.



This cut represents the method of setting the water supply pipe to Injector; when Valve *B* must be changed to an ordinary



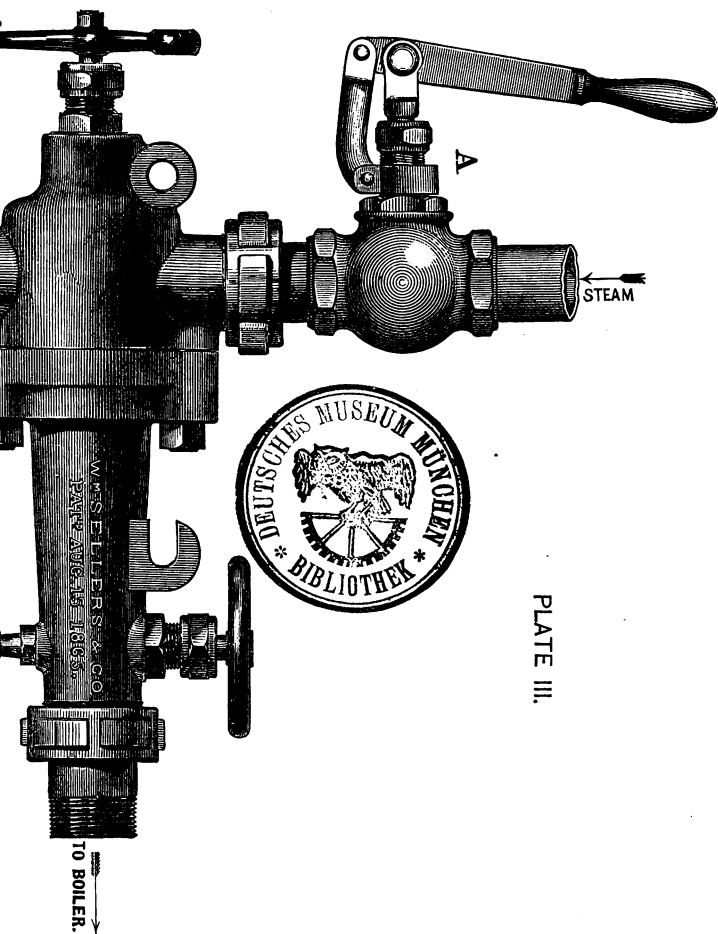


PLATE III.

ting the Injector where there is a considerable pressure  
 re the water is lifted by the Injector, the Regulating  
 Check Valve.



FIG. 42.

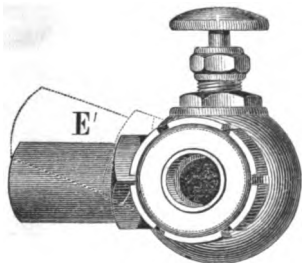
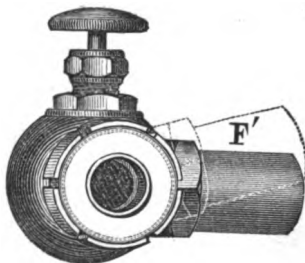


FIG. 43.



(E.) INGRESS HORIZONTAL FOR RIGHT  
SIDE, WITHOUT FLANGE.

(F.) INGRESS HORIZONTAL FOR LEFT SIDE,  
WITHOUT FLANGE.

(E' & F'.) EGRESS INCLINED UPWARDS.

FIG. 44.

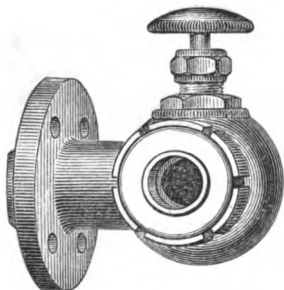
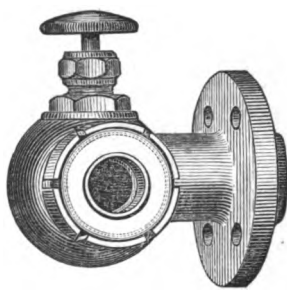


FIG. 45.



(G.) INGRESS HORIZONTAL FOR RIGHT  
SIDE, WITH FLANGE.

(H.) INGRESS HORIZONTAL FOR LEFT SIDE,  
WITH FLANGE.

This arrangement is shown in Plate III. Here we have a sort of balance valve, in which the water from the supply presses upon the inner face of the valve, and also upon the small piston on the same stem, whose outer surface opens to the air through the case. These surfaces are so adjusted that the valve would

Water regu-  
lating valve.

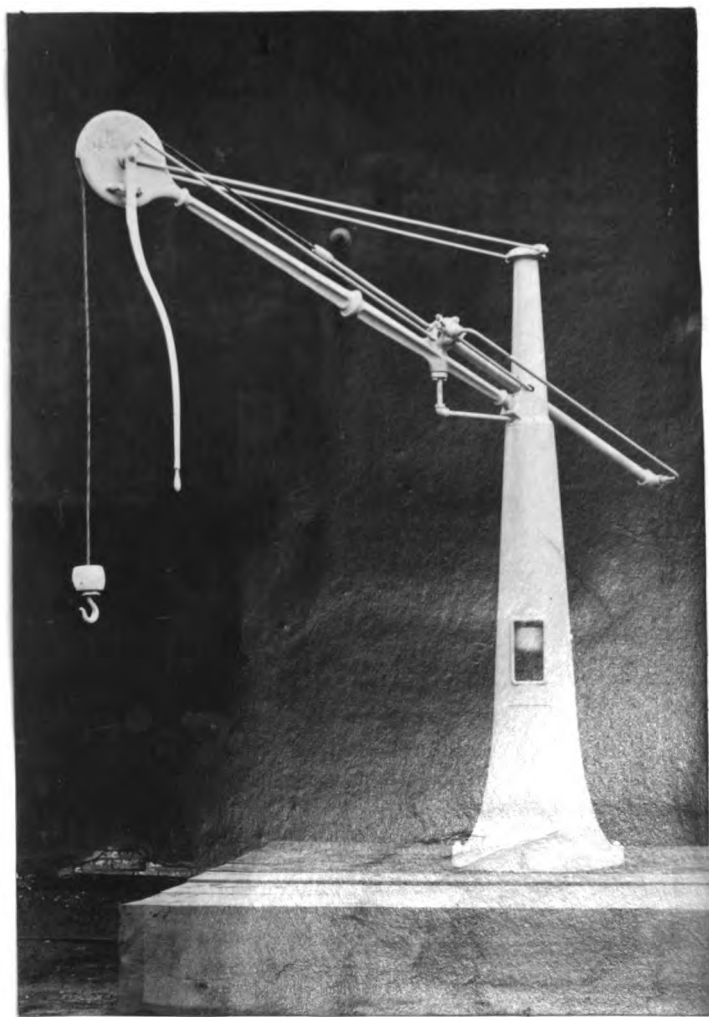
remain closed by reason of the water pressure; but if a partial vacuum is produced in the pipe, *D*, by the action of the injector, then the valve will be opened by this force, the amount of its opening being controlled by the position of the stem which is detached from it.

Of course any pressure in the pipe, *D*, will at once close this valve, so that it acts also as a check valve, which would cause the steam to pass through the alarm check into the waste pipe, so as to attract notice.

In conclusion, we may add that the most convenient method of using waste heat to raise the temperature of the feed water with the injector, is to pass the water from the instrument through a closed heater where it can take up the waste heat, and not to attempt to heat the water before it enters the injector. By this means, using the exhaust from an engine as the source of heat, about 70° may be added to the heat of the water fed.

Use of a heater.  
  
Injector utilizing exhaust steam.

A somewhat similar result may be obtained without a closed heater, by arranging an injector so that it may take in exhaust steam, thus raising the temperature of the water fed to boiler. We build instruments with this attachment, which can be advantageously used in situations where a pipe from the exhaust escape can be carried to the injector. Condensation in this pipe must be avoided, as the instrument will not draw in water from it.



## HYDRAULIC MACHINES.

Hydraulic pumping engines—Hydraulic accumulators for high and low pressures—Platform hoists, operated by water—Hydraulic moulding cranes for car wheels.—Also large water cranes for foundry use, arranged with very superior valves, and designed with especial view to durability and convenience; as well as hydraulic punching, riveting, and forging machines.

Transmitting  
power by  
water.

HAVING been engaged for many years in the manufacture of hydraulic machines, we have accumulated a large assortment of patterns of the various useful appliances of this very convenient mode of transmitting power and of using it in machines. We are prepared to furnish all that may be required for the introduction of hydraulic motors and machine tools into warehouses or workshops.

Pump and a-c-  
cumulator.

Use in this  
country.

The very great convenience of the hydraulic system of working hoisting machines has caused its introduction into some of our largest works, and the improvements introduced recently have tended to materially decrease the first cost of the plant needed. This first cost, which may seem great when a single machine or hoist is to be operated, becomes trifling when the use of the power is extended to a wider range of machines. Thus, in any event a pumping engine and accumulator are required; but when these two machines are in place a very considerable number of machines or hoists may be operated from the same source of power with less cost for each machine, and very much less cost of conducting the power to it, than by any other known method. In this country the use of this power has been mainly confined to hoisting

machines ; but we have recently extended its use to all purposes of shearing, punching, and riveting machines, as also to forging presses and like purposes. We give on page 217 a photograph of a very convenient crane for moulding purposes,—one of the series of machines designed by us for the use of the Pennsylvania Railroad Company in their wheel foundry at Altoona. In this machine the weight is raised and the empty hook lowered by power, with very little loss of water, so that the usual heavy ball at hook is not required, facilitating its use. The hand lever is near to the work, thus dispensing with an assistant to move the valve.

Water lifts  
for Pa. Rail-  
road.

We have also arranged convenient ladle-tilting machinery for car-wheel foundry, and automatic cranes for placing the red-hot car wheels in the annealing pits. Some of the machinery of this description made by us has been in operation for more than fifteen years, without any notable need of repair. We have also extended its use to other machines for special purposes, clearly demonstrating the advantage and economy of the mode of operation.

Ladle-tilting  
machine.

The universal employment of the hydraulic system in the operations incident to the Bessemer process has rendered many persons familiar with its use ; but while the direct-acting crane commonly used in handling the ladles and ingot moulds in the Bessemer mills seems simple and convenient, it is wholly inadmissible with the greater loads and higher lifts needed in foundries. We have therefore adopted the system of drums and chains common to all foundry cranes, with the addition of convenient and durable water engines to impart the necessary rotary motion. They are so arranged as to materially economize the power

Use of water  
cranes in the  
Bessemer  
mills.

Foundry  
cranes.

over any plan heretofore brought to our notice, using water only in hoisting, not in lowering weights.

Breaking machines.

We have patterns also for breaking machines for casting, one having a lift of forty feet, weight of drop one ton, and a smaller one of ten feet lift and one ton drop.



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